AN ONTARIO SURVEY

FOREST INDUSTRY AUTOMATION

PREPARED FOR:
INNOVATION AND TECHNOLOGY DIVISION
MINISTRY OF INDUSTRY, TRADE AND TECHNOLOGY

Government of Ontario

Ministry of Industry, Trade and Technology

FOREST INDUSTRY AUTOMATION STUDY

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for

Innovation and Technology Division

Ministry of Industry, Trade and Technology

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Ontario

Minister of
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Dear Reader:

The importance of Ontario's forest industry is well documented. In 1983, output stood at $7.2 billion; exports at $2.6 billion; direct employment at over 75,000, with an additional 75,000 jobs indirectly dependent upon the industry.

It is vital that the Ontario forest industry remain competitive. In today's international market, the need to upgrade productivity and quality present constant challenges. Automation technology is one of the principal means of strengthening performance.

This report explores the opportunities for forest industry automation from an Ontario perspective. It contains a broad review of:

- current technology use in the Ontario forest industry; and
- opportunities for further automation in silviculture, harvesting and sawmilling operations.

The report is based upon an extensive survey of forestry operations in Ontario and over 80 industry representatives were consulted.

One of the guiding principles of this government is that we consult closely with industry in matters of common concern. In releasing this report we hope to stimulate discussion and to help focus energies in meeting the challenges facing the forestry industry.

In doing so, we will continue to ensure the important contribution that this industry makes to the provincial economy.

Hugh P. O'Neil
Minister

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1.0

SUMMARY

1.0 SUMMARY

1.1 Recommendations

Study findings show a critical need to improve productivity and profitability. The areas with the greatest potential to benefit from better automation are:

- management skills,
- improved machinery, and
- new processes.

1.2 Scope of Study

This study was to be a broad technical review of the Ontario forest industry to identify automation opportunities.

1.3 Background to the Ontario Forest Industry

Ontario has three main forest areas :

- Northern, which is predominantly softwood
- Central, which is mixed hardwoods and softwood
- Southern, which is deciduous.

The forest industry cuts timber from Crown land through Timber Licenses and Forest Management Agreements.

The forest industry has excessive capacity of low value products, and under capacity for higher value products.

Ontario's forest industries provided 20% of Canadian forest products exports in 1983, $2.635 billion, representing 6.3% of the total provincial exports.

1.4 The Industry Surveyed in the Automation Study

The main emphasis of this study was concentrated on Silviculture, Harvesting and Sawmilling, with limited examination of veneer, plywood and reconstituted panel manufacture.

1.5 The Automation Survey

A physical survey was conducted by questionnaires, telephone calls and visits to the district offices of the Ontario Ministry of Natural Resources, to logging operations and to sawmill operations. The results in Section 5.0 show a reasonable degree of automation and mechanization in Silviculture and Harvesting, and very little state-of-the-art automation in sawmilling.

1.6 The Potential for Automation

1. Siviculture practices are labour intensive, offering good potential for additional mechanization of seedling production, site preparation, planting and stand tending. Management control systems already make extensive use of computer programs. The most immediately beneficial opportunity would be to standardize on quality software programs.

2. In harvesting, automation potential is limited except in the softwood forests. Standardization of hardware and software programs would be beneficial.

3. Sawmilling offers major opportunities for improved productivity and improved yields through automation. If total Quality Control in softwoods, from sawlog bucking through to kiln drying and shipping were implemented, the sawmills could recover up to 20% more lumber from the same log volume input.

Significant improvements could also apply to hardwoods. Total Quality Control would significantly reduce the volume of low grade residuals.

4. Veneer and plywood manufacture could benefit from some additional automation even though most already are using "state-of-the-art" technology. The main opportunity for improved recovery of veneer would be conversion to optimizing automatic X-Y charger systems for the lathes.

5. Reconstituted panel products operations are already fully automated. There would be opportunities, however, to decrease fibre cost, or to make more fibre available, by using the maxi-chipping and ring flaking concept.

1.7 Constraints to Automation

We have listed twelve constraints which create a reluctance to venture into automation.

We believe most of these constraints could be removed by a co-ordinated effort between industry and government.

1.8 Other Opportunities for Profitability Improvement

There are a number of opportunities outlined in addition to those identified in the Automation Study. Most involve low cost improvements that provide a high return. We suggest you need more Creative Marketing to improve sales value of your products. There is a need to develop value-added secondary manufacturing opportunities, as well as a need for new processes to utilize problem materials, such as small logs, chips and residuals.

2.0

SCOPE OF STUDY

2.0 SCOPE OF STUDY

This study was based on a request, dated 3rd December 1984, by the Ministry of Industry and Trade for a well-grounded technical review to determine automation opportunities in the forest industry of Ontario as a preliminary to further work to be undertaken by the Ministry.

To gain the maximum benefits from this review, the scope of the study was allowed to evolve, as the status of the industry was investigated, into the following :

- An examination of automation in the industrial sectors of;

  - Silviculture
  - Harvesting
  - Sawmilling
  - Veneer and Plywood Manufacture
  - Reconstituted Panel Product Manufacture.

  Examination of the latter two sectors to be limited to a state-of-the art review of these processes. Veneer and plywood being limited because this is largely a declining industry unlikely to justify the capital cost of modernization. Reconstituted panel manufacture being limited because this is fundamentally an automated process.

- A definition of the following;

  - Current level of automation in the industry
  - Identification of future automation opportunities
  - Likely costs and benefits, in descriptive rather than detailed terms.

To permit closer examination of automation opportunities in such diverse industrial sectors, sector-specific definitions of automation were defined as follows :

- In Silviculture and Harvesting, to include advanced machinery and/or micro-electronics.

- In Sawmilling, to be limited to systems which include micro-electronics and sensors.

- In Management Control of all three sectors, to be any system which uses computer programs to enhance the decision making ability of human beings.

Secondary manufacturing of wood products was not to be included.

Pulp and paper manufacturing was also not to be included.

3.0

BACKGROUND TO THE ONTARIO FOREST INDUSTRY

3.0 BACKGROUND TO THE FOREST INDUSTRY

3.1 The Ontario Forest

The forest in Ontario is made up of three forest areas. Northern Ontario consists of the boreal forest region, primarily softwoods (Jack Pine, Spruce, Balsam Fir, Poplar and White Birch). Central Ontario is the Great Lakes - St. Lawrence Forest area (Pine, Maple, Hemlock and Yellow Birch), and Southern Ontario is the deciduous forest area (Maple, Oak, Beech and Basswood, see Figure 3.1).

The terrain of the productive forest land is quite variable, particularly in the mixed wood areas. Regeneration in the Great Lakes - St. Lawrence forest region and particularly in the deciduous forest region is difficult and the method of cutting on crown land is Government controlled to ensure better regeneration. The diversity of the land, forest and terrain is of particular significance to this study. Weather, soil, rocks, water, bush, hills, distances, are factors which deny in their diversity, any simple single solution. They generally present the most hostile of environments for the operation and maintenance of sophisticated machinery.

Of particular significance to the application of large scale mechanized equipment is the extent to which individual stands can be clear-cut. The opportunity to clear-cut varies with the homogenity of the stand in species and maturity as well as market and other conditions. The mixed and hardwood forests in particular demand selective logging and management.

In the past, the forest has been severely depleted by selective removal of the biggest and best trees. This depletion has created a serious problem in the mixed wood and deciduous forest regions. The forest industry is now left with a poor wood resource and has to find a product and market for this wood.

The productive forest land base of Ontario is largely owned by the Crown. Forest management is conducted for the people of the province by the Ontario Ministry of Natural Resources (OMNR) who control the harvest and regeneration through a system of timber licenses and Forest Management Agreements. These are based on Forest Management Plans designed to promote the most beneficial systems of silviculture and harvesting consistent with economic and other realities.

The forest industry cuts timber, from Crown land, through Timber Licenses and Forest Management Agreements.

The Forest Management Agreement (FMA), through security of tenure, encourages the forest products companies to invest in better harvesting techniques to ensure improved forest regeneration. The company can cut timber on the agreement area over the next 20 years, pay stumpage fees for the amount cut, prepare site for planting, plant trees, and build roads. The government will partially fund regeneration and road costs.

A Timber License is an agreement between the government and the company that the company can cut a certain amount of wood from a licensed area and pay stumpage fees on the amount cut, and an annual charge for the timber licence. Pulp and paper companies are given tenures up to 21 years. Other forest companies are given tenures up to 10 years. Most of the large pulp and paper companies have replaced their timber licenses with the FMA's.

In central and southern Ontario, some of the productive forest land base is privately owned and the forest companies arrange for wood purchases or wood harvesting from the private land owners.

Professional foresters and technicians staff the OMNR District offices of the eight Administrative Regions. However, they are so thinly spread over the wide and complex forest that Ontario is considered to be still in the "exploration ... administration ... and regulation" phases of forestry, and not into true management. (Armson 1976 and Heikurinen 1981).

The diversity of the forest combined with the demands of the market dictate the manufacturing process. The species, quality, size and shape of the trees combined with transportation distances as well as a host of other considerations, such as a supporting infrastructure, all influence the manufacturing process. Only the most economic manufacturing process will survive, therefore, the forest and the forest management policies of the OMNR are crucial.

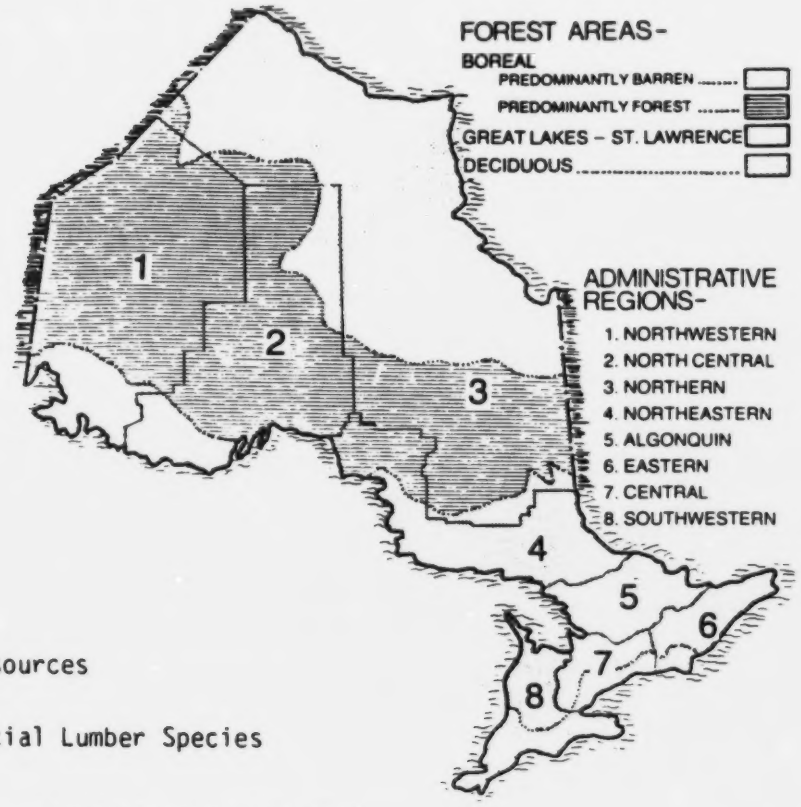


FIGURE 3.1
THE ONTARIO FOREST

- The Main Forest Areas
- Ministry of Natural Resources Administrative Regions
- The Predominant Commercial Lumber Species

Exemplified by: 1983 Lumber Production by Species
(Thousands of Cubic Metres)

Region	Spruce, Pine, Fir & other Softwoods	Red and White Pine	Birch, Oak Maple and Other Hardwoods	Poplar	Total
1. North Western	367	8	-	-	375
2. North Central	726	13	3	-	742
3. Northern	1,465	15	1	8	1,489
4. North Eastern	451	161	106	1	719
5. Algonquin	39	246	134	59	478
6. Eastern	18	23	30	3	74
7. Central	1	20	30	2	53
8. South Western	1	2	58	4	65
Total	3,068	488	362	77	3,995

3.2 Forest Products Manufacturing

From the seventeenth century, the forests of Upper Canada have provided a base of industrial development. First to provide masts and lumber for the French and then for the British Navies. As settlements developed and communities grew, the forest industry responded. Expanding population and industry created the need for construction lumber, rail ties and a widening range of wood products. Standard specifications and grades developed. Increasingly the trend was to the supply of lumber as a standard commodity to be remanufactured into a finished product close to the point of end-use.

The forests of eastern and southern Ontario supplied timber from the wide range of species which the first settlers found. Magnificent White and Red Pine together with Maple, Oak and Birch met their needs. The variation of species, quality and size gave the early industry the ability to select the trees which best met the market requirements. Expanding markets put increasing pressure on the resource. Lesser species, lower quality and smaller trees were utilized. The industry began to move north into the boreal forest.

By the end of the ninteenth century the pulp and paper industry had begun. The production of White and Red Pine lumber was at its peak with irreversible decline about to begin. The pulp and paper industry developed rapidly in the first two decades of the twentieth century and sawmills spread northwards from the Ottawa Valley - Algonquin - Muskoka Parry Sound areas. The post-war economic boom and population growth brought increased development in pulp, paper, lumber, veneer and plywood plants. This expansion established the industry in the northeastern and northwestern areas of the province committing the industry to the forest base which it harvests today.

The last fifteen years marked a period of substantial modernization. Sawmills adjusted to the construction lumber market by installing high-speed small log production machinery capable of manufacturing a narrow range of commodity softwood lumber from the smaller coniferous trees of the northern boreal forests.

Sawmills committed to the mixed species and hardwood areas had increasing difficulty to compete as they work with trees of diminished size and quality at higher costs and with insufficient volumes to benefit from economy of scale. This same later period saw the introduction of a substantial new process industry as reconstituted panel-board plants were built. Their utilization of sawmill residue as well as the unexploited Poplar forest added new dimensions to the industry as did the large expansion of kraft pulp capacity during the same period.

A significant factor in the more comprehensive utilization of the forest in the 1970's was the Provincial Government encouragement of better use of the higher quality sawlog timber whereby pulp mills had to build their own sawmills or give up the harvesting rights. One result of these policies is an industry containing large integrated corporations operating together with smaller independent, and often privately owned, companies.

Another important consideration to the understanding of the industry today is the large capital expenditures made in recent years in response to federal and provincial initiatives in pollution abatement.

The Industry Today

Today the forest industry of Ontario is well adapted to the overall utilization of the forest upon which it is based. It is not well adapted to the market it services.

The sawmill industry, which is the main concentration of this study, illustrates the predicament of an industry constrained by the facts of the forest and the social - geographic - economic environment and yet compelled to compete with national and international suppliers of similar commodities. During 1984 near record volumes of softwood construction lumber was imported by the U.S.A. at depressed sales values because of the increased production capability of a modernized high-speed sawmill industry.

Hardwood lumber sawmillers are severely limited in competition with their U.S. counterparts partly by freight distances but mainly by size, species and quality of the trees available.

The remaining hardwood stands, by now severely depleted through earlier selective logging, supply relatively small volumes of high value lumber and much greater volumes of low-grade material. Markets for low-grade lumber are limited and prices are low. Yet low-grade lumber has to be produced and the cost of production is as high, if not higher, than the better grade lumber being cut from the same sawlog.

More productive and profitable machinery could be employed in the forest and in the sawmills. Greater mechanization and automation could extract more lumber from the same trees and perform better, more valuable and more economic work. However, the capital cost of greater mechanization and automation is high. Adequate return on investment generally requires higher production volumes than that of very many of the small sawmills.

On a strictly economic basis, there are too many sawmills. There is an excess productive capacity of low value products and not enough capability to manufacture higher-value products. This is a most serious crisis for the industry which significantly affects the question of automation. The need for the industry to be profitable is a matter of survival.

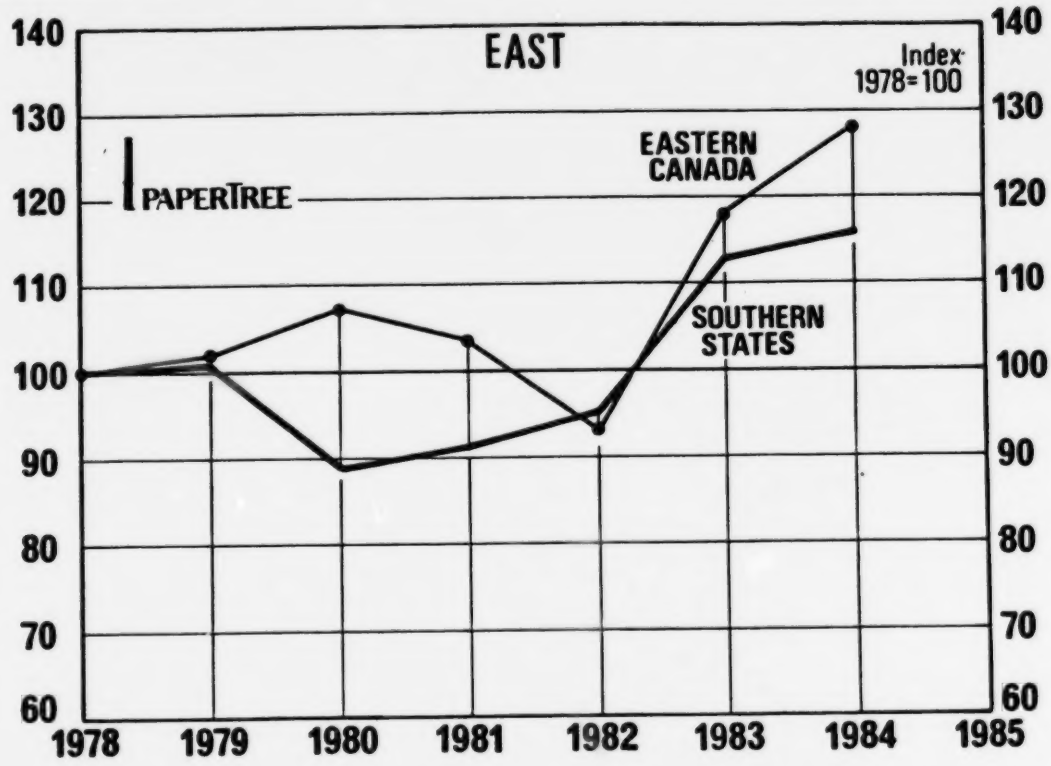
The implications of the situation are well described in the April 1985 issue of PaperTree Letter, which is quoted here by permission of the publisher, PaperTree Economics Ltd. of Vancouver, British Columbia :

Lumber In The Mid-1980's
... it takes more than just record consumption

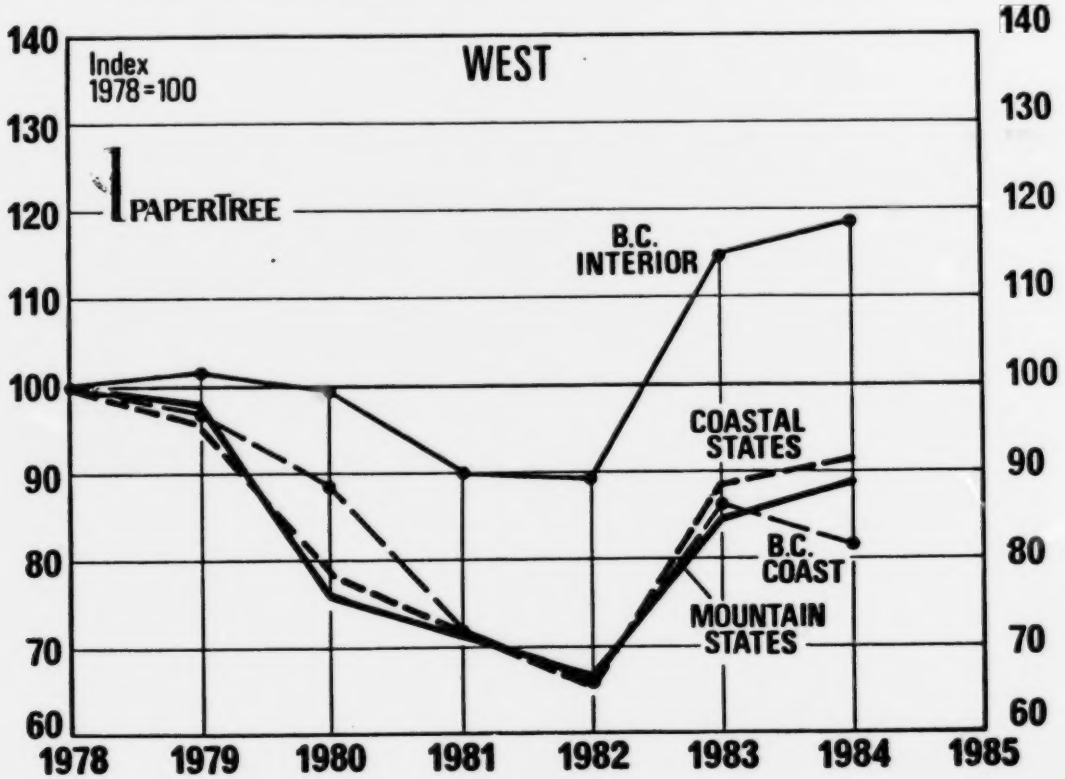
U.S. demand for softwood lumber established a new all-time record last year, marginally surpassing the 1978 peak. At 4.28 billion board feet, and 37% above the total for 1982 - the sharpest two-year increase since World War II.

The tendency of lumber prices to remain near their lows for the cycle - in spite of the record increase in demand - can only be a result of too much production. But whose production? Since the 1978 peak in North American demand (and output), there has been a dramatic change in market shares among the different regions, with the change primarily along East/West lines. Eastern and Southern lumber regions have surged ahead, to record levels of lumber output in 1983, and new records again in 1984. Meanwhile, West Coast mills in both Canada and the U.S. have been forced down, many of them permanently.

FIGURE 3.2
REGIONAL LUMBER
PRODUCTION HISTORY



Regional Changes in North American Lumber Production Since the 1978 Peak



These curves in Figure 3.2, show the development of production during the past six years, **relative** to its 1978 level. If we also consider the **absolute** levels of output for the different regions, we see how uneven has been the regional participation in the modes (2%) increase in overall production: Western sawmill output, in total, has **dropped 4.4%** since 1978; East of the Rockies, total output has **increased 14.5%.**

Why the Regional Shift?

If there is one reason for this Eastward shift of lumber production, it is cost differentials. Eastern and Southern mills have continued to increase their competitiveness, for a variety of reasons. One of the factors facing West Coast producers (both loggers and sawmillers, in both the U.S. and Canada) is a strong labour movement and the costly work practices, as well as high wage rates, which that implies. In addition, B.C. Coast logging operators are trying to cope with a critical shortage of economically accessible timber (there's lots of accessible timber, but more and more of it is not economic); sometimes this "coping" takes the form of a permanent mill shut-down.

Eastern and Southern mills not only are relatively free of those negatives, but also enjoy a number of real positives:

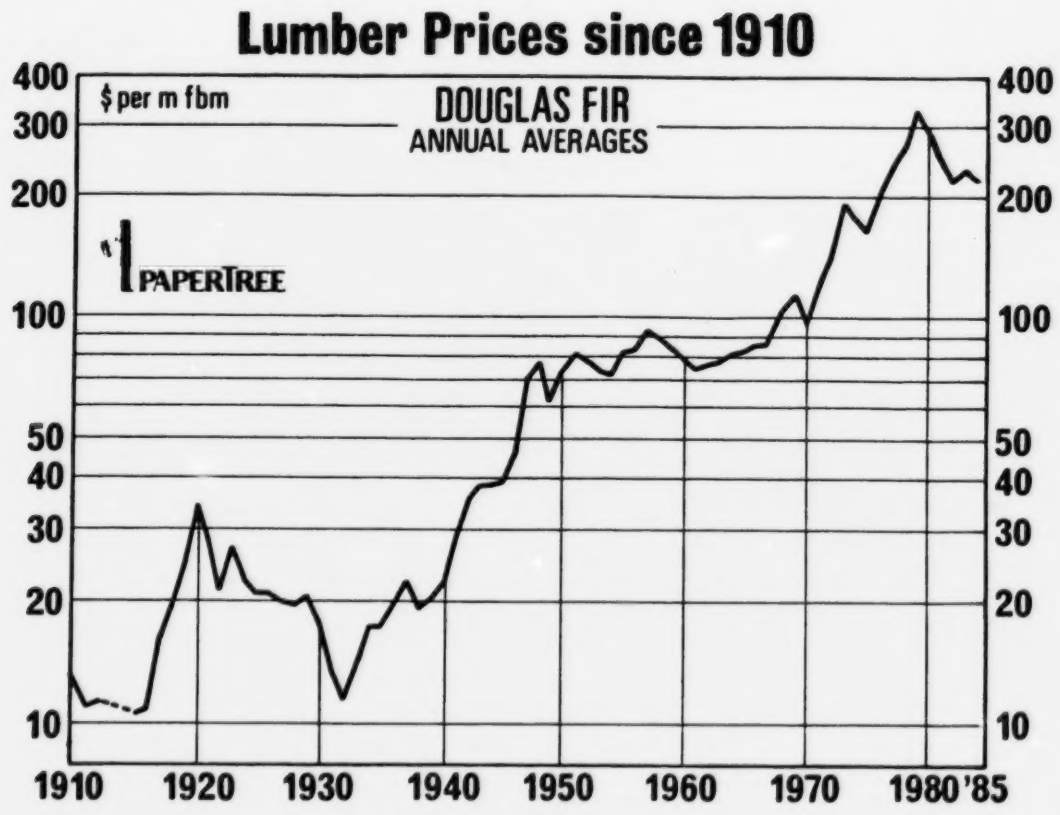
1) Technological developments in sawmilling during the last 10-15 years have enabled much more effective sawing of the small-diameter timber which is normal in Eastern producing regions. In effect, a lot of pulp logs have become sawlogs.

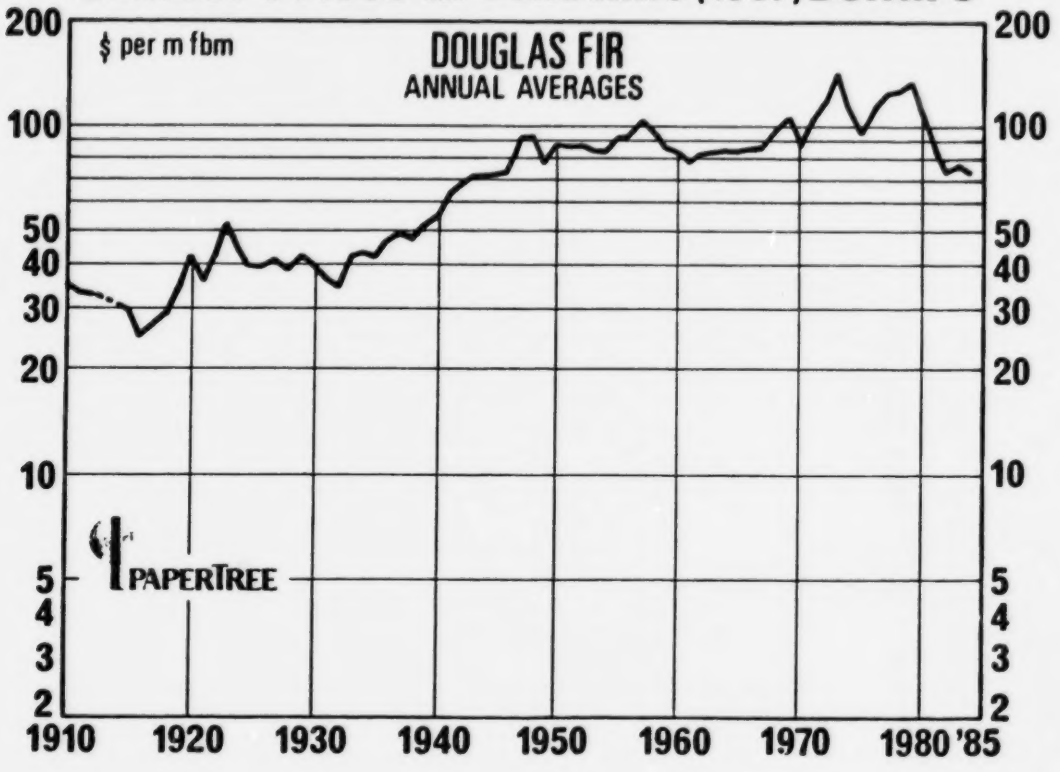
As well, more and more groundwood based papers such as newsprint are being produced from chips instead of roundwood, thus expanding the market for sawmill residues. These two factors have diverted an increasing proportion of the timber from pulp mills to sawmills, and supported the steady modernization of lumber capacity in the East. A positive feedback loop is completed as the modernized plant produces more lumber, generates more cash flow and, in a desperately competitive industry, enables further modernization.

2) Transportation costs, particularly in Canada, have continued to increase, which of course has its greatest effect on those mills which are furthest from the major markets. Rail freight from B.C. to Eastern Canada is up 60% since 1978. The Eastern lumber industry has made effective use of truck transport to build up a service-oriented distribution system. This would be difficult and expensive for Western mills to match.

3) The strongest economic performance and hence the major growth in demand, has been in the Eastern half of the continent. The National Forest Products Association's regional breakdown of demand shows a 15% increase in the Southern Pine region's demand for softwood lumber between 1978 and 1984. Demand on the other Eastern U.S. regions was up 9%, while the West (combined) was down 7%.

FIGURE 3.3 - LUMBER PRICE HISTORY





4) In Ontario, improved standards of forest management have resulted in re-directing some of the allowable harvest from the major paper companies (who commonly have not used all their allocation) to the smaller operators, who almost by definition are sawmillers. This has opened up more harvesting, and hence more Eastern lumber production.

Prices Are Even Worse Than You Think

U.S. lumber prices are now virtually back to their lows of the cycle, established in 1982. They are down 45% since June 1983, while interest rates and housing starts have changed very little, and lumber consumption has increased substantially.

But when we take a long-term view of prices (Figure 3.3. top) the recent cyclical break not only appears as unusually severe, but for the first time it has not been followed by a recovery. And when the inflation factor is removed from the data (Figure 3.3 lower) the full horror appears: real prices have suffered their worst drop of this century. In spite of demand rising to record levels, over production has prevented any price recovery whatsoever.

Will It Ever End?

The most ominous aspect of the current situation is that this may be as good as it gets. All the housing indicators have held up at very high levels for the past two years, and now look as though they may not last much longer. U.S. lumber demand, having just made a new high, also seems likely to be heading the other way before long.

Since most of the North American lumber industry has been unable to make money with domestic demand at an all-time high, and offshore demand not far from it, there seems no way out of the excess production other than a **major, enforced shrinkage** of the industry's capacity. That has already been happening to a significant extent. More than 10% of Coastal B.C. sawmilling capacity has been permanently closed, and the same forces are at work in the Western U.S. But during the next 2-3 years, as demand follows its normal cyclical course (downward), there must be many more closures. West Coast mills will continue to be hardest hit, unless they are able to **radically** reduce their total costs.

- End of PaperTree quotation -

The forest industry represents a significant element in the economy of Canada and Ontario.

The development of the industry has been influential in the settlement and social life of Canada. Today the forest industry provides direct employment for some 50,000 people. In fact, the economic well-being and sometimes the survival of many communities is dependent upon the forest industry. Northern Ontario is dominant in terms of wood harvested and the manufacture of primary forest products. The dependence of northern Ontario on the forest industry is illustrated by the fact that, in 1978, 77 percent of the total employment in manufacturing in the northwestern region, and 20 percent in the northeastern region respectively was forest based. This contrasts with the more highly industrialized south where the forest industry provided only 6 percent of the total employment of all manufacturing jobs.

A period of crisis has existed for this industry for the past several years. No resolution of the difficulties is in sight, only a shifting of emphasis as the challenge of the many different problems are attacked. The history of the industry has been one of adversity and hardship. It is relatively no less so today. The main difficulties come from:

- Decreased international trade due to the world wide recession.

- Increased competition for the booming U.S.A. market has flooded that market with lumber resulting in depressed and dangerously low product values.

- A shrinking forest base of diminishing log quality and increasing log cost.

- Almost complete exposure to international competition. The industry operates in a classical free-market. Supply exceeds demand for most solid and reconstituted wood products. Very many independent producers, domestic and foreign, compete in a buyer's market. Prices fluctuate on an almost continuous basis even, for standard commodities, varying as the products are transported.

- Over-capacity, provincially, nationally, and globally resulting from several factors. Among the smaller producers, this industry has been one having a low capital cost of entry. The policies which directed the industry to full utilization induced the large pulp and paper companies to build large commodity-lumber producing sawmills. Improved forest utilization both at home and overseas, and increased industrialization in the developing nations have contributed to a global surplus.

- Heavy debt loads have resulted from the expansion and modernization phase of the late 1970's which was followed by recession and high interest rates.

- Limited market access, particularly for those producers competing with those close to the end-users such as the United States and Scandinavian manufacturers.

- A highly paid work force accustomed to the inflated social expectations of a deficit financed society, in relation to their competitors.

FIGURE 3.4

THE EXPORT OF ONTARIO FOREST PRODUCTS 1983

Primary Products	$,000	% of Canadian Total
Logs and Bolts	650	0.4
Round Timber	155	1.0
Pulp Wood	367	3.2
Pulp Chips	3,676	4.1
Other Crude Wood	1,387	8.6
Lumber and Timbers	624,380	15.6
Railway Ties	232	12.3
Other Sawmill Products	2,272	0.9
Millwork	20,415	16.0
Veneer	57,139	33.0
Plywood	12,347	8.7
Other Fabricated Wood	84,414	57.8
Wood Pulp	38,564	17.6
Printing Paper	1,073,354	24.3
Fine Paper	59,326	67.8
Tissue Paper	23,980	71.5
Wrapping Paper	22,829	19.6
Paperboard	26,881	15.2
Building Paper	13,041	17.7
Converted Paper	69,616	76.6
Total Primary Products	**2,635,025**	**20.0**

Higher Value Products	$,000	% of Canadian Total
Furniture and Fixtures	280,075	72.4
Toys, Sports Goods, etc.	53,854	51.5
Printed Matter	190,498	50.8
Office and Artists Supplies	13,214	68.1
Total Higher Value Products	**537,997**	**61.0**

Source: Ontario Ministry of Natural Resources

Ontario has provided 20% of Canadian forest products exports in 1983 for a total of $2.635 billion, representing 6.3% of the total provincial exports. Figure 3.4, top, shows the list of primary forest products exported in 1983. The "% of Canadian Total" of "Higher Value Products" shown at the bottom of Figure 3.4, indicates that Ontario does manufacture more of the higher value products than the rest of Canada. This is not wholly due to the maturity of the industry, since Ontario is closer to larger markets. The potential exists to further increase the value added contribution made by the forest industry to the provincial economy.

4.0

THE INDUSTRY SURVEYED IN THE AUTOMATION STUDY

4.0 THE INDUSTRY SURVEYED

The purpose of this section is to describe the industrial processes surveyed in the automation study.

The forest industry, from seedling to finished product, contains a wide variety of manufacturing processes. Their main divisions may be considered to be:

Silviculture:	The establishment and management of the forest.
Harvesting:	The extraction of the log harvest.
Sawmilling:	Conversion of logs into lumber and pulp chips.
Veneer Manufacture:	Peeling logs to provide veneer and pulp chips.
Plywood Manufacture:	The assembly of veneers into plywood panels.
Reconstituted Panel Manufacture:	The conversion of logs and sawmill residues into particles and their reconstitution into panels.
Pulping:	The conversion of logs and sawmill residues into pulp.
Paper Making:	The conversion of pulp into paper.
Remanufacturing: (or Secondary Manufacturing)	The conversion of lumber, plywood, reconstituted panels, pulp and paper into finished consumer products.

The main emphasis of this study, especially the industrial survey, is concentrated on the processes of Silviculture, Harvesting and Sawmilling.

The processes of Veneer, Plywood an Reconstituted Panel manufacture were limited, in this study, to a review of typical automated state-of-the-art examples.

4.1 Silviculture

Silviculture as the basis of the forest industry is the establishment and nourishment of the forest through intensive forest management until harvest and replacement with new and, if possible, genetically superior stocks.

Silvicultural practices are site specific and vary considerably throughout the province. For the purpose of the Automation Survey, the process has been examined under the following functions:

1 - **Regeneration**
2 - **Site Preparation**
3 - **Stand Tending**
4 - **Management Control**

1 - Regeneration

Forest regeneration is the renewal of a forest crop by natural or artificial means. There are two types of tree nursery operations in Ontario; bareroot and container.

Bareroot production in Ontario is about 78 million seedlings per year from 11 nurseries. Bareroot stock are grown from selected seeds and the trees are raised outside in nursery beds for two or three years. Bareroot nurseries are government owned.

Container seedling production is about 68 million per year from 28 nurseries. Container nurseries are relatively new and use mechanized equipment. Container nurseries are privately owned and operated. The seeds are sown in containers and raised in greenhouses for some twenty weeks before planting.

Container stock is less expensive to produce and plant. Bareroot stock is larger, stronger and is planted in areas where there is a problem in competition with weed species.

The forest products companies with forest management agreements have their own staff or tender out planting to private contractors to plant on their agreement areas. The government (OMNR) contracts out tree planting to the private sector to plant on the Crown lands other than the Forest Management Agreement areas.

2 - **Site Preparation**

Site preparation is the treatment of soil and ground cover to prepare the soil surface for favourable reception of naturally sown, artificially sown or nursery grown stock. Mechanical methods involve the removal from the organic soil layer physical obstacles like slash debris to provide a mineral soil seed bed with reduced competing vegetation. These include scarification, trenching, discing, raking, etc.

3 - **Stand Tending**

Stand tending has the objective of improving the rate and quality of wood production. This is achieved by clearing, thinning, pruning, spacing and fertilizing.

Clearing is the removal of competing weed species from the planted stock during the seedling stage of growth.

Spacing is the removal of young trees to provide even growth space.

Thinning is the spaced cutting of immature stands to provide better growth space and to accelerate diameter growth. A thinning at some ten to fifteen years provides the best biological and economical results.

Pruning is removal of dead or redundant live branches from the bole of the tree to promote the growth of clear (knot-free) wood.

Fertilization is the maintenance of vigorous growth by the artificial replenishment of any nutritional deficiencies.

4 - **Management Control**

Management control of the regenerating and growing forest until harvest has a wide range of computer assisted potential. The applications range from seedling records, planting and growth yield records to forest inventory, mapping, cruising, etc.

4.2 Harvesting

The basic operational functions of extracting the log harvest are simply explained. The functions are the same throughout Ontario, only the degree of mechanization varies.

1. Felling

Trees are felled individually, either manually (chain saw) or with mechanized equipment (feller-bunchers, feller-forwarders).

2. Skidding

Transporting the felled trees from the bush to the landing, or roadside, either dragging them with a Grapple Skidder or Choke Skidder (trees are individually choked), or else carrying them with a Forwarder.

3. Delimbing

The limbs of the trees are removed by chain saw either in the bush, landing or by a mechanized delimber at the roadside.

4. Bucking

Cutting the trees into transportable lengths, or sawlog lengths. This may be done in the bush, at the landing or at the log yard.

5. Sorting

At the landing or at a sorting area according to species, occasionally according to size and quality.

6. Management Control

There are a wide range of management functions in Harvesting which can benefit considerably from computerization. These range from mapping, cruising and annual allowable cut calculations to equipment maintenance planning and the engineering of logging roads, etc.

4.3 Sawmilling

As in silviculture and in harvesting, the sawmilling processes used in the industry of Ontario vary immensely. It is important to understand especially in the context of this Automation Study, that sawmills have to be designed and operated to suit both the trees and the market. Flexibility is vital to meet higher value market opportunities and to utilize a wider range of logs. Too often flexibility is exchanged for a compromise which process costs less.

Sawmills vary in size. In 1983, 759 sawmills operated in Ontario.

- 613 produced less than 10 Mfbm per shift.
- 88 produced between 10 and 50 Mfbm per shift.
- 58 produced over 50 Mfbm per shift.

Sawmills vary in type:

- **Hardwood** sawmills cut for grade. They have to be the most flexible, highly decision intensive and be quality and market responsive.

- **Softwood dimension** sawmills cut varying lengths and sizes mostly for the construction commodity market, sometimes for the shop market. Again, very decision intensive.

- **Small log** sawmills, mostly in the boreal forest, have to process large numbers at high-speed to produce economic volumes. Operator decisions become increasingly difficult at these higher speeds.

- **Stud-mills** produce 2 x 3, 2 x 4 and 2 x 6 studs, eight feet long, for the construction market. Few operator decisions. Easiest to mechanize and automate.

Despite the wide variety of sizes and types of sawmill, it is possible to define process functions which are common to all. For the purpose of this Automation Study the sawmill process has been surveyed under the following process functions:

1. Sawlog Preparation
2. Primary Breakdown
3. Secondary Breakdown
4. Grading
5. Sorting
6. Drying
7. Finishing
8. Management Control

1. Sawlog Preparation

From delivery of the raw logs until the resulting sawlogs are ready for sawing several basic functions are performed.

Receival; The logs are received as delivered. They will range from final sawlog lengths to full tree lengths.

Scaling; The volume of the delivered logs has to be recorded.

Storage and Handling; The logs have to be unloaded from the delivery vehicles, placed into storage, held in storage and delivered for further processing as required.

Bucking; The process of cutting the raw logs into the best lengths for the manufacture of lumber. (If the logs have been bucked into short lengths in the bush the decision as to the best length has been denied to the sawmill).

Debarking; The removal of bark.

Sorting; The direction of the bucked segments into their manufacturing destination. Only in the most optimized sawmill would all the possibilties for the highest value end use occur. Such choices could include;

- Pulpwood for chipping
- Plywood peeler logs
- Sawlogs sorted by species, quality, lengths, diameter and possibly shape characteristics like taper, crook, etc.

2. **Primary Breakdown**

The primary breakdown process is the critical first sawing operation performed on the prepared sawlog. The log is examined and then sawn into the combination of cants, flitches and boards which will produce the highest value of finished material. The process is critical to obtain the highest values by grades, lengths, widths and thicknesses from a frequently varying market.

3. **Secondary Breakdown**

The cants, flitches and boards produced by the primary breakdown machines are converted into rough green lumber through three or four secondary breakdown processes.

Gang Sawing is the process by which the cants (standard sized sections of the log) are converted into lumber. This involves feeding the cant, which frequently requires orientation to obtain the highest value recovery, through a battery of fixed saws.

Re-sawing is the process by which the flitches (sections of the log containing several potential boards) are sawn into thinner thicknesses.

Edging is the process by which the flitches are sawn into one or more narrower widths to produce finished rough lumber. It is frequently used to remove external defects and, when necessary, to reduce lumber in width to optimize market values.

Trimming is the process of cutting the rough lumber into standard market lengths. As with edging, it also involves the selective removal of defects to optimize values.

4. **Grading**

The identification of the market grade by assessing the strength and appearance characteristics of each piece of finished lumber. In general, softwood lumber is graded as a whole piece mainly on the basis of strength characteristics. Hardwood lumber is graded on its useable content for different end-uses within the piece.

5. **Sorting**

Depending upon the different processes being performed on the lumber during the whole sawmill process the pieces may have to be sorted several times. Sorting may be done separately or in combination of length, width, thickness, grade and species.

6. **Drying**

Lumber may or may not be dried depending upon market requirements.

Lumber is sometimes air-dried but this process is of long duration requiring large inventory and yard space. Apart from being weather dependent, it is difficult to control both for uniformity in final moisture content and to avoid the development of drying defects.

Kiln-drying is the normal process. In softwoods, duration may vary from one to seven days depending upon thickness and species. Careful control is required to ensure uniformity and to avoid defects, such as splitting, warping and cupping.

7. **Finishing**

Several finishing functions may be performed before the lumber is shipped.

Planing is the process of shaving down the sawn lumber on 2 or 4 sides, to achieve accurate final sizing and to produce an acceptable surface finish.

After planing final **trimming, grading** and **sorting** may be required.

Packaging is considered to be the final process before **shipping.** This involves stacking the sorted lumber, applying strapping, labelling, wrapping and moving into and out of **inventory** as required.

8. **Management Control**

The sawmill process usually requires many operator decisions to produce the lumber sizes and grades demanded by the market. The machinery used in the process is sometimes not adequate to consistantly cut accurate sizes.

The complexity of the operator decisions to get the highest values from the logs make computer systems an attractive management tool.

4.4 Veneer and Plywood Manufacture

Veneer and plywood manufacturing operations in Ontario vary in size and in scope of production programs. In many cases the veneer and plywood plants are combined with sawmilling operations, have integrated log preparation systems and share plant support facilities.

The following basic types of veneer and plywood operations can be identified :-

- **Hardwood Veneer Plants** produce rotary cut or sliced veneers from hardwood species for the manufacture of industrial grade (furniture type) plywood panels and for the overlay of other types of reconstituted wood based panels.

- **Hardwood Plywood Plants** use rotary cut and in some cases sliced veneer, produced in their own operations or purchased from other sources, to manufacture industrial grade plywood panels for furniture industry, wall panelling, door manufacture and other industrial use. Hardwood plywood normally has 1 to 2 mm face veneers and up to 4 mm core veneers, peeled from hardwood species and bonded with interior type adhesives, typically urea formaldehyde resin.

- **Softwood Plywood Plants** use rotary cut veneers, typically 2.5 to 3 mm thick, peeled from coniferous species, for the manufacture of construction grade (exterior) plywood panels. Bonding of veneers is done with exterior type adhesives, typically phenol formaldehyde resin. The principal use of softwood plywood is in construction of houses and other exterior applications.

Softwood and hardwood veneer and plywood operations include the following basic process functions:

1. Block Preparation
2. Green Veneer Production
3. Veneer Drying
4. Dry Veneer Preparation
5. Lay-up and Pressing
6. Finishing
7. Management Control

1. Block Preparation

The block preparation consists of the following functions:

Receival - Logs are delivered and received at the mill.

Scaling - The volume and species of the delivered logs are recorded.

Storage and Handling - Logs are unloaded from the delivery vehicles, placed into storage area, protected by sprinklering (if necessary) and delivered for further processing.

Debarking - The removal of bark is usually done after conditioning in hardwood plywood operations and before conditioning in softwood plywood plants.

Cutting to Length - Logs are cut into a peeler block length. Sawlog grades are cut into the best length for the manufacture of lumber.

Sorting - Peeler blocks, sawlogs and reject logs are sorted and transferred for further processing. Peeler blocks are accumulated in block bins or transferred directly into conditioning system. Reject logs and off-cuts are usually converted to pulp chips.

Conditioning - Peeler blocks are transferred to block conditioning which is done by immersion in heated water or by spraying with hot water in drive-in chambers. Pre-heating of peeler blocks is necessary in order to achieve a smoother and tighter veneer and a greater full sheet recovery. Conditioning in drive-in chambers is a batch type operation with blocks being handled by a log loader. The heating system could be fully automated and could be designed as a closed loop system. Conditioning in immersion vats is a continuous process. The infeed and reclaim of peeler blocks as well as the heating system could be fully automated and programmed.

Preparation of Flitches - For sliced veneer operations logs are converted into flitches usually by a horizontal band saw. Flitches are conditioned in steam or hot water tanks and delivered to veneer slicers.

2. Green Veneer Production

Debarked and heat treated peeler blocks are peeled by a lathe into a continuous ribbon of veneer.

A typical method of handling green hardwood veneer is reeling it onto spools which can be stored on vertically or horizontally arranged storage racks. This procedure allows the lathe to operate at optimum capacity without being slowed down by the clipper or dryer speed. It is common practice to combine the veneer reeling system with a single or multiple tray deck system to handle round-up veneer and thicker veneer which could not be reeled. In softwood plywood operations peeled veneer is conveyed to a clipper on multiple belt tray decks or the lathe is directly coupled to a clipper by means of a single or double deck transfer system.

A scanner checks the veneer ribbon for knot holes, open splits and other defects and controls the clipper to cut the widest usable veneer sheet. Modern plants are equipped with full sheet selectors and automatic stackers for sap and heart veneer sheets.

3. **Veneer Drying**

Hardwood veneer stored on spools can be either clipped to sheet sizes in green condition (with appropriate shrinkage allowances), or can be unreeled, feeding a continuous veneer ribbon into a conveyor type dryer and clipped to size after drying.

Full sheets of softwood veneer could be automatically fed into a dryer feeder mechanism. Random width veneer is manually preloaded into the pinch rolls of the dryer feeder for an automatic distribution into the individual decks of the veneer dryer.

Dried veneer is sorted by sizes and grades.

4. **Dry Veneer Preparation**

Dry Veneer preparation includes re-clipping, patching, jointing, splicing, etc. The extent of these operating functions depends on the type of plywood panels produced, method of lay-up system and other conditions.

5. **Lay-up and Pressing**

In this phase of the process veneers are coated with glue, laid up into assemblies and subsequently subjected to temperature and pressure in a hot press in order to activate the thermo-setting resin and bond the veneers into plywood.

6. Finishing

The finishing phase may include the following functions :-

- Trimming the plywood panels into finished size, sanding, grading, panel patching, tongue and grooving, etc.

7. Management Control

The main objectives of the management control are to achieve :-

- the highest possible recovery of finished products from the given wood input,

- the highest value of the products by maximizing the top grades and by up-grading,

- the highest productive efficiency.

4.5 Reconstituted Wood Panels

The most common classification of reconstituted wood panels is by grade and by the principal production method.

- By Grade:

a) Structural Grade Panels: Waferboard, Oriented Strandboard (OSB), Core Board (for composite panels), Insulation Board.

b) Industrial Grade Panels: Particleboard, Medium Density Fibreboard (MDF), Hardboard.

- By Production Method:

a) Flake or Particle Type Products: Waferboard, Oriented Strandboard (OSB), Particleboard.

b) Fibre Type Products: Hardboard, Medium Density Fibreboard (MDF), Softboard (insulation board).

The reconstituted wood panel plants operating in Ontario include the following types of processes :

- **Hardboard Plants** - producing compressed fibreboard with a density usually exceeding 800 Kg/m^3.

- **Insulating Board Plant** - producing non-compressed fibreboard with a density not more than 350 Kg/m^3 (known also as softboards).

- **Particleboard Plants** - manufacturing process using small pieces or particles of wood, as distinguished from fibres, blended with a synthetic thermo-setting resin and bonded under heat and pressure into a panel product. The principal user of particleboards is the furniture industry.

- **Waferboard/Oriented Strandboard Plants** - manufacturing process is a modification of the particleboard technology. Large area flakes or elongated strands and exterior type synthetic resin characterize the differences.

The production method of reconstituted wood panels is a continuous almost fully automated operation which makes it substantially different from batch type operations of veneer and plywood plants. From the time the material is reclaimed or loaded on an infeed conveyor, it is handled and processed automatically until a finished panel is discharged from the press and transferred to the finishing area.

The basic process functions are, with some exceptions, common to all reconstituted wood panels. They include :-

1. Particle or fibre generation
2. Drying
3. Screening and blending
4. Mat forming
5. Pressing
6. Finishing
7. Management Control.

1. Particle or Fibre Generation

The source of raw material for reconstituted wood products varies from operation to operation. It may include sawdust, shavings, chips, off-cuts, roundwood, etc. The process functions in this area of the plant may include all or some of the following activities:

- Receiving and storage of raw material
- Reclaim of raw material
- Screening, washing, conditioning, chipping, flaking, defiberization, classification, etc.

2. **Drying**

The moisture content of green particles or flakes is reduced in hot air stream of flash dryers to approximately 3%. Fibres for wet process hardboard or insulating board are not dried prior to further processing.

3. **Screening and Blending**

Dry particles or wafers are classified into surface and core fractions, blended with powder form or liquid resin and other chemicals and conveyed to a forming station.

4. **Mat Forming**

Forming station spreads surface and core furnish into single or multi-layer mat in a controlled way for the required thickness of the board.

5. **Pressing**

Single or multi-opening presses consolidate the mats under heat and pressure into board products.

6. **Finishing**

The finishing phase may include the following functions;

- Trimming the boards into finished sizes, sanding, grading, tongue and grooving, etc.

7. Management Control

The main objectives of the management control are to achieve;

- A consistent quality (physical properties) of the board products
- The optimum productive efficiency.

5.0

THE AUTOMATION SURVEY

5.0 THE AUTOMATION SURVEY

In an industry so diverse there can be no single definition of automation, not just because of the diversity of operations but also because of a widely different potential for automation existing. Some of the processes of the industry lend themselves readily to automation, some seem almost inconceivable of automation. So one single definition would exclude too much. Too wide a definition would dilute the study. For example, the sawmilling process has much potential for automation in the strictest sense of the word, silviculture has little. There is substantial potential for productivity improvement in silviculture and harvesting through improved mechanization. However, if improved mechanization in sawmilling were to be considered the opportunities for improved productivity are so many that the benefits of automation would have to be neglected. For these reasons it was decided to use different definitions of the term "automation".

Webster's dictionary defines **automation** as: "any system or method that uses self operating equipment, electronic devices, etc. to replace human beings in doing routine or repetitive work".

To achieve a sufficient scope of this study, it was decided to apply three different derivations of the dictionary definition.

- **Automation in Silviculture and Harvesting**
  is: "any system or method that uses advanced machinery **and/or** micro-electronics to enhance the productivity of human beings".

- **Automation in Sawmilling**
  is: "any system or method that uses a combination of machinery **and** micro-electronics **and** sensors to enhance the labour **and** decision making ability of human beings".

- **Automation in Management Control**
  is: "any system which uses computer programs to enhance the decision making ability of human beings".

A physical survey was made to determine the level of automation existing in three sectors of the industry :-

- Silviculture
- Harvesting
- Sawmilling.

The survey was conducted in three stages:

- Questionnaires were mailed to a significant section of the operators in each of the industrial areas and the responses analysed.

- Telephone interviews were conducted with respondents and others.

- Visits were made to a very limited number of operations.

Three groups of people were issued questionnaires, telephoned and visited, these were :-

- The district offices of the eight Administrative Regions of the Ontario Ministry of Natural Resources.

- Logging operations.

- Sawmill operations.

Time and budget limited the survey. The wide variety of people and industrial operations, the large distances involved, all are factors militating against a more definitive survey. Nevertheless, a consistency of findings emerged, and were corroborated by opinions, which provide confidence in the findings.

FIGURE 5.1

SCOPE OF AUTOMATION SURVEY

- **Among the Ministry of Natural Resources District Offices**

Region	1	2	3	4	5	6	7	8	Total	
Questionnaires Mailed	7	4	6	7	7	4	5	1	41	
Responses Received (% of total)	4	1	4	5	6	3	4	1	28	(68%)
Telephone Interviews		1	3	3	2				9	
Visits Made				2					2	

- **Among the Logging Companies**

Region	1	2	3	4	5	6	7	8	Total	
Questionnaires Mailed	3	9	14	8	7	2			43	
Responses Received (% of total)	1	4	7	3	3	1			19	(44%)
Telephone Interviews	1	3	8	3	2	1			18	
Visits Made				1	1				2	

FIGURE 5.2

SUMMARY OF AUTOMATED AND ADVANCED MECHANIZATION FOUND IN SILVICULTURE

Process	OMNR Jurisdiction		Logging Company Jurisdiction		
Planting	All Manual			All Manual	
Site Preparation	8	-	Disc Trenching	-	3
	8	-	Power Scarification	-	4
	12	-	Blades	-	5
	26	-	Ploughs and Rakes	-	0
	9	-	Barrels and Chains	-	3
Stand Tending	5	-	All Methods	-	0

5.1 Automation in Silviculture

Silviculture is a responsibility of both the Ministry of Natural Resouces and of logging companies. The scope of the combined Silviculture and Harvesting survey is shown in Figure 5.1 (top opposite). The response to the survey was high. Everyone interviewed was interested and encouraging.

The results of the survey of Automated Mechanization in Silviculture are summarized as in Figure 5.2 (lower opposite).

Planting was done manually in every operation contacted. This confirms the overall impression that any mechanical planting in Ontario is of a limited developmental nature.

Site Preparation was found to employ a variety of scarification machinery ranging from powered ground breaking and tilling equipment to simple chains with barrels to drag the surface.

Stand Tending was found to be minimal in total, with hand tools only being used.

Management Control through the application of computer programs showed a fair amount of use, a lot more than in sawmilling for example. The result of the survey is summarized on Table 5.4. As Silviculture and Harvesting was the result of a common survey and uses overlapping management systems, any further observations will be reserved for the Harvesting section, 5.2.

FIGURE 5.3

SUMMARY OF AUTOMATED AND ADVANCED MACHINERY FOUND IN HARVESTING

Process	Level of Automation
Felling	14 - Manual (chainsaws)
	4 - Feller Bunchers
	4 - Feller Forwarders
Skidding	14 - Choke Skidders
	4 - Grapple Skidders
Delimbing	8 - Manual (chainsaws)
	11 - Mechanical Delimbers

5.2 Automation in Harvesting

The Harvesting survey was combined with Silviculture so the scope of survey is as shown in Figure 5.1.

The survey findings with respect to the level of automation or mechanization are summarized in Figure 5.3.

5.3 Summary of Automated and Advance Machinery Found In Harvesting

Felling still has a high manual content but advanced felling machinery is also well used. The choice of systems is significantly dictated by the nature of the forest. Manual methods are still necessary in the selectively logged mixed hardwood forests.

Skidding is all by skidders or by forwarders. The only difference is in the size and quality of skidding and forwarding equipment.

Delimbing is again dictated by the forest type. While mechanized delimbers can cope with most of the branches of the softwood trees. only chainsaws are able to handle the heavy limbs of the hardwood forests.

FIGURE 5.4

SUMMARY OF COMPUTERIZED MANAGEMENT SYSTEMS

FOUND IN SILVICULTURE AND HARVESTING

	SYSTEMS FOUND	
Computer Program	**OMNR Jurisdiction**	**Logging Company Jurisdiction**
Mapping	4	3
Forest Inventory	12	9
Operational Cruising	15	7
Growth and Yield	10	4
Scaling	13	-
Equipment Maintenance and Scheduling	3	2
Silviculture Planning and Records	12	6
Financial Planning and Cost Control	10	7
Simulation and L.P.	-	2
Production Planning and Scheduling	-	6
Forest Engineering	-	-
Total Responding	**28**	**18**

Management Control through the use of computer programs in Harvesting is summarized in Figure 5.4.

While the number of programs found to be used, among those sampled, was not high it is proportionally more than in sawmilling. Discussions also confirmed a greater interest in the use of computer programs by these respondents than, generally speaking, the sawmill respondents.

It should be noted that the use of computers in mapping is at an early stage in that most of the users were only using, on a test basis, the GIS System based at Lakehead University.

Another reservation is that the rather high level of computer use in the OMNR operations is perhaps based on older technology. The impression gained is that this may merely be reporting, by means of manually completed data cards, and not inter-active programs to assist management control and decision making.

Harvesting Survey Conclusions

There is little automation even when the definition of the term has been expanded to include advanced mechanization. There is no resistance to improved mechanization and automation, only formidable constraints which are considered in Section 7.0.

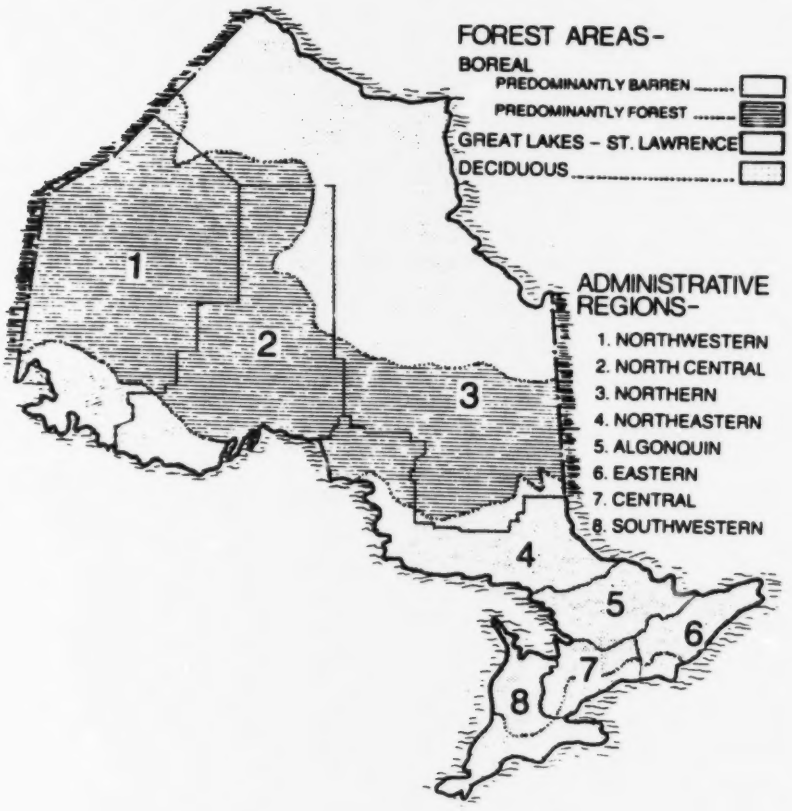


FIGURE 5.5

DISTRIBUTION OF SAWMILLS

Region	Production Level (Mfbm/shift) 0 - 10	10 - 50	50 +	Total
1. North Western	54	13	10	77
2. North Central	41	6	9	56
3. Northern	42	14	18	74
4. North Eastern	119	17	10	146
5. Algonquin	109	26	9	144
6. Eastern	104	3	1	108
7. Central	79	4	1	84
8. South Western	6	5	0	70
Total	**613**	**88**	**58**	**759**

5.3 Automation Existing in Sawmilling

Economics suggest that automation is most likely to be found in the higher production operations. The economic production levels will be lower in hardwood sawmills than in softwood mills.

Figure 5.5 shows the distribution and size of the sawmills of Ontario. This shows the very large number of small producers where automation is not at all likely. It shows the larger producers in the predominantly softwood stands of the northern regions and the medium sized operations of mixed softwood and hardwood areas.

The survey concentrated on the hardwood and softwood mills which have production levels above the most minimum to support automation.

The scope of the sawmill survey is indicated in Figure 5.6.

FIGURE 5.6 - SCOPE OF SAWMILL AUTOMATION SURVEY

Production Level (Mfbm/shift)	Under 10	10-50	Over 50	Total
- Questionnaires Mailed	6	17	46	69
(% of total)	(1)	(19)	(79)	(9)
- Responses Received	2	7	18	27
(% of mailed)	(33)	(41)	(39)	(39)
- Telephone Interviews	0	4	18	23
- Visits Made	0	2	3	5

FIGURE 5.7 - SUMMARY OF AUTOMATION FOUND IN SAWMILL PROCESS CONTROL

Process	Number of Automated Processes
- Log Bucking	- None
- Log Sorting	- 7 using, 1 planning to use
- Log Scaling	- 1 using
- Primary Breakdown	- 9 using, 1 planned
- Secondary Breakdown:	
- Edging	- None installed, 3 planned
- Trimming	- None installed, 2 planned
- Lumber Sorting	- 12 installed
- Lumber Drying	- 5 installed, 1 planned
- Lumber Grading	- 1 installed, 1 planned
Total Responding	**27**

Automation in Sawmill Process Control

The survey found only a small number of sawmill process control systems have been automated within the definition of the term used in this study.

The findings are summarized in the Figure 5.7.

The introduction of automation into sawmilling has been a process of perfection of machinery, computers and software over the last decade. Some automation systems may be considered to be reasonably mature while others are experiencing a high rate of obsolesence.

Automation in lumber sorting is quite mature. Their proven reliability in operation and their effectiveness in reducing manpower requirements explains the relatively large number of automated systems.

While computer controlled primary breakdown systems have been used in the industry for eight to ten years, the last three to five years have seen substantial improvements particularly in their scanners and software. Most of the Ontario systems surveyed, are obsolete. Consequently, there is much potential for improvement.

FIGURE 5.8 - AUTOMATION ON ALL KNOWN ONTARIO CHIP-N-SAWS *

OPERATION	CHIP-N-SAW	PROCESS CONTROL SYSTEM	YEAR
Great Lakes Forest Products	Mark III	KCC Scan-N-Set	1982
MacKenzie Forest Products	Mark III	Not Known	
	Mark II	CanCar Log Gauge	
		Not Known	
Dynast Forest Products	Mark I	Rema	1978
	V6	A.S.I.	1979
Kimberly Clark, Longlac	Mark II	A.S.I.	
Kimberly Clark, Terrace Bay	Mark II	Nothing	-
Domtar (Abitibi Price), White River	Mark II	A.S.I.	1978
	V6	A.S.I.	1978
Spruce Falls Power & Paper	Mark II	A.S.I.	1980
	Mark II	A.S.I.	1980
Abitibi Paper, Smooth Rock Falls	Mark III	Nil	-
	Mark II	Nil	-
Eddy Forest Products, Timmins	CanCar F.T. Canter	KCC Scan-N-Set	1980
Eddy Forest Products, Nairn Centre	Mark II	KCC Scan-N-Set	1979
	Mark II	KCC Scan-N-Set	1982
	KCC F.T. Canter/Twin	KCC Scan-N-Set	1981
United Sawmills	Mark II	KCC Scan-N-Set	1978
	V-6	Nil	-
Chapleau Lumber	V-4	A.S.I.	1978
Elk Lake Planing	Mark I	A.S.I.	1979
	V-4	A.S.I.	1979
Great Lakes Forest, Thunder Bay	Mark III	Nil	
	Mark III	Nil	

* Based on information believed accurate at time of survey, but not verified.

For example, the information in Figure 5.8 summarizes the process control systems believed to be still in use on the twenty-five Chip-N-Saw primary breakdown systems in Ontario. All systems listed here are obsolete. Some are merely electronic log diameter gauges which indicate a recommended machine setting to the operator. None of the software programs listed employ realtime solutions. (All this being to the best of our knowledge at the time of the survey).

FIGURE 5.9 - SUMMARY OF COMPUTERIZED SAWMILL MANAGEMENT SYSTEMS IDENTIFIED IN THE SURVEY

Computer Program		Systems Identified, With Comments
Production Monitoring	-	6 limited systems used
	-	1 advanced system planned
Production Planning	-	1 used
Lumber Size Control	-	1 used
Quality Control	-	2 planned
Maintenance Planning	-	1 used
	-	1 being installed
	-	1 planned
Log Inventory Control	-	2 advance systems used
	-	2 limited systems used
	-	1 being installed
	-	2 planned
Lumber Inventory Control	-	4 used
	-	1 planned
Personnel Records	-	4 used
Personnel Training	-	1 limited system used
Total Responding	-	27

Automation in Sawmill Management Control

The sawmill survey identified the management programs listed in Figure 5.9 as being in use.

Compared to machine and process control applications, sawmill management computer programs are a new development. It is only within the last three to five years that software designers have been addressing the needs of this relatively small market with its highly individualized operations.

Therefore, while the number of sawmills taking advantage of automated systems are low, the recent availability of programs, and perhaps their inadequate presentation to the industry, makes the failure to take advantage somewhat understandable.

What is surprising is that only one sawmill contacted reported the use of a Lumber Size Control program for Quality Control purposes. These programs have been available for several years. They are well publicized and can be purchased for as little as $1,000. While computers are not essential, they do enhance the opportunity to achieve the maximum benefit from lumber size control. In sawmilling lumber size is probably the single most important factor in Quality Control. Lumber Size Control programs should be implemented in all sawmills to assist in obtaining optimum productivity and profitability.

Conclusion

This overall situation, of a low number of automated systems and a high degree of obsolescence in the primary breakdown systems particularly, indicate that significant opportunities exist to improve the productivity of the sawmill industry by means of automation.

6.0

THE POTENTIAL FOR AUTOMATION IN THE INDUSTRY SURVEYED

6.0 THE POTENTIAL FOR AUTOMATION

The purpose of this section is to review the potential for automation which exists in the forest industry of Ontario. In this context we are considering automation both in direct process control, which in silviculture and in harvesting has been expanded in definition to include improved mechanization, as well as in management control. We are taking the very limited automation which presently exists and outlining the automated system which could be automated using the proven and commercially available technology being applied and developed today.

In considering automation within the forest industry of Ontario, particularly as we consider the manufacturing processes which begin with the planting of a seedling and the shipping of a railcar load of lumber, we are contemplating a challenging diversity of tasks spread over geography, time and manufacturing operations. Climate, terrain, generations of Canadian development and unforeseen industrial processes and markets lie between us and our market products. In considering automation in the forest industry of Ontario, we consider a wide scope.

In this study we do not consider the pulp and paper industry. The automation of that industry is, in comparison, relatively straight forward as the material being processed has been reduced to fairly homogenous and controllable characteristics. We do consider veneer, plywood and reconstituted wood panel products.

This study is limited to the primary solid wood products of the forest. The final solid wood products, such as furniture parts, bed, window, door frames, and the hundreds of other relatively high valued products are not considered. This study is of automation in an industry which begins in the forest, and with the planting of a seed.

6.1 Automation Potential in Silviculture

Most of the processes in Silviculture are difficult to mechanize, quite apart from trying to automate. There is a fragmentation of development in the mechanization of silviculture. The potential market for the mechanization of silviculture practices today is greater than the economy of Canada can handle (Silversides, 1984). Like logging, most silviculture practices are labour intensive and mechanization could greatly improve productivity. With the enormous areas to be covered high productivity is critical, probably more so than cost (Silversides, 1984).

While the potential is great, the benefits will be harvested by future generations from investments which will be sown by this generation. And, in silviculture most of the investment decisions are by government, not industry.

1. Seedlings

Of the trees artificially grown in Ontario, 50% are bareroot and 50% are container stock. The percentage of container grown stock will increase but there is a limit because bareroot stock will still be required for the more difficult planting sites.

The container nurseries are relatively new and most of the nurseries are using mechanized equipment. The nurseries have peat and fertilizer mixers. The mixers are manually fed and the peat and fertilizer is mechanically mixed.

A peat filling line fills the containers with peat, compacts the peat in the containers, and spreads vermiculite on top of the containers. The tray of containers are taken off the filling line conveyor and placed on the seeder conveyor.

A vacuum drum seeder seeds each container. The tray of containers is then manually placed in the greenhouse.

When the tree seedlings are ready for shipping, the trays are manually placed into trucks.

In the bareroot nurseries, the seed is sprayed onto prepared nursery beds. The tree seedling is then lifted from the nursery bed and replanted in the tree nursery fields. After a couple of years the trees are lifted from the soil using lifters (partially mechanized), packaged into boxes (manually) and shipped out to the planting sites. The production and the efficiency of the bareroot nurseries has been poor. The bareroot nurseries are very labour intensive operations. Containers will gradually replace bareroot stock because of lower cost planting and lower cost of production.

Computer control systems for seedling production will expand. These computer systems can be programmed to regulate watering, fertilization and ventilation.

Information on the number of seedlings in the bed throughout the growing season is necessary to manage production and distribution with optimum efficiency. Current seedling inventory practice, based on statistical estimates derived from laborious hand-sampling, yields inventory errors of the order of $\pm$15 percent. Inventory techniques offering improved accuracy, speed, convenience and knowledge about the seedling growth characteristics are needed by the seedling industry and government.

Researchers have demonstrated the use of optical methods to measure tree seedling length and stem diameter and for counting seedlings on the lifter or grading belt.

A prototype opto-electronic system is being developed to inventory tree seedlings directly in the nursery bed. Count signals are obtained from the interruption of an infrared light beam by the individual seedling stems. The micro-computer based system is designed to mount on a tractor tool carrier platform and to count seedlings in one double row as the tractor moves along the nursery bed (Kranzler and DeVoe).

Automated systems being used or developed for use in the commercial agricultural industry have application in tree nurseries where the environment is similar.

One example of a research project (Hwang and Sistler, Louisiana State University) which combined a robotic manipulator with a commercial mechanical transplanter and a micro-computer has been reported.

Bar codes can be placed on seedlings in the nursery. A permanently affixed I.D. tag will allow for foresters to keep track of the location of the tree, track its growth and determine when it is ready for harvest.

In the University of North Carolina, they have been working on a seedling selection and sorting system that uses a photoelectric cell and linear potentiometer (thickness gauge).

A major weak point in regeneration is the interface between nursery and field planting. Cold storage trucks and cold storage field areas are required to maintain seedling quality up to the point of planting.

2. Planting

Virtually all tree planting in Ontario today is manual. The primary tool in bareroot planting is still the shovel. For container stock, the planting tools range from the Pottiputki (hand planting tool) to various types of tubes and mattocks and modified versions of the shovel. Planting bags and trays are the most common carriers.

The Ontario Centre for Resource Machinery Technology has assisted in manufacturing and marketing a carrier called the Grizzly. It is a 16-wheeled, industrial all-terrain vehicle for use in carrying the tree seedling to the planting site.

Mechanized tree planting is in the very early stages of development. No commercial unit is presently operating in Ontario, although they have been tried and interest is strong. It is felt that the next five years will see a lot of development.

FERIC (Forest Engineering Research Institute of Canada) plan to publish a summary in the next months, on the "Review of Furrow and Spot Planting Equipment in North America and Europe". This reviews six machines. FERIC are also starting a project to investigate increasing productivity of manual tree planting. (Ernst Stjernberg, FERIC, 1985).

Some mechanized systems of note are:

- **Timberland Planter** (Ontario Tree Planter) - 1980 scarification and machine planting takes place together.

- **Reforester Planter** (Alan Moss & Associations) - plants Walters Bullet container. It has microprocessor circuitry.

- **Hodag Tree Planter** (Timberland Equipment Ltd.) - it has a two row mechanically activated dibble.

- **Lakehead University** - two row intermittent planter for container seedlings. Planter utilizes a hydraulic mechanical planting mechanism.

- **FERIC** - was involved in an experimental planter for paper pot containers, two years ago, on contract with the Ministry of Natural Resources. Lack of funding cancelled the project.

- **Tetra Automatic Planter** (Equipments Denis Inc., Rosalie, P. Quebec) - a modular system including site preparation and planting.

- **Silva Nova** (Storebro Bruks AB, Sweden) - also incorporates site preparation and planting.

3. Site Preparation

Almost all the areas being replanted today are site-prepared. Improved logging practices due to the conditions of the relatively new Forest Management Agreements result in less logging residues to hinder site preparation equipment.

Equipment more highly suited in design is being perfected. All are factors working toward a better environment for the automation and improved mechanization of site preparation equipment.

Much more research is required on the determination of specific site conditions required for the most productive seed-stock and species. For example, the main requirement for Pine is warm soil early in the growing season, this implies baring the mineral soil. Spruce requires a mixture of duff and mineral soil for best results. Therefore, site preparation must be both site specific and species specific.

Site preparation is relatively new in Canada (started about 25 years ago in Ontario). Most of the equipment used is still locally made and not highly mechanized. Because of the variety of terrain and newly developing applications and operations there are at least 45 different types of scarifiers that are in use in the boreal forest region in Canada. About 40% are manufactured in Canada (Great Lakes Forest Research Centre, Mechanization of Silviculture Eqiupment Information Bank). There are some companies using sophisticated machines that have hydraulic down-pressure discs and powered cultivating discs.

Relatively slash-free full-tree logged sites are more easily treated with lighter implements and smaller prime movers immediately after logging.

In certain areas, there is a trend towards increased utilization of hardwood species left standing after logging. FERIC have developed durable, wide, high flotation tires that can be used on wetlands.

The following summarizes the equipment currently available:

- Barrel and chain drags are still used, however they have severe limitations including low mobility, poor maneuverability, high maintenance costs and a requirement for high horsepower.

- Blades and rakes are also still used, but they have grown expensive to operate and tend to be overly harsh (this may be attributable to equipment conditions and operator technique).

- The C.F.S. V-Blade and more recently the Fesco V-Plow were developed specifically to provide single row site preparation for trailed mechanical planters.

- The mechanical TTS disc trencher is the practical application of the agricultural disc. The TTS Delta with hydraulic down-pressure to provide more positive ground contact. TTS also has a unit with hydraulic rotational power to the discs to provide a more positive trenching action.

- The Bracke spot scarifiers mechanize hand spot scarification.

- More technically sophisticated is the Leno Patch Scarifier. The most significant refinement has been the addition of a hydraulically actuated shovel attachment to the Bracke designed to create mounds.

- Donaren Powered Disc Trencher is a powered head unit. Hydraulic trenchers were designed for use with the Scandinavian forwarders and incorporate high horsepower and high flotation. Because of lack of similar prime movers, the market has been limited for these units.

- Marttinni Plow and C-S Reforestation Plow. Both give continuous plowing and are used in winter, in wet organic soils.

- The Ministry of Natural Resources has developed a hydraulically articulated scarifying arm known as the Bigfoot Scarifier for use with low horsepower skidders.

- A powered cone head scarifier has been developed on Koehring shortwood harvesters owned by Great Lakes Pulp and Paper.

4. Stand Tending

The long term benefits, to future generations, of the improved volume and quality of the Ontario forest requires present investment. Government policies and expenditures are providing a gradual beginning.

At this time the work is all manual and performed with hand tools such as brush-saws and chain-saws. More productive equipment is needed but the incentive or demand seems to be lacking. Automation potential does not seem great because the situation today is as follows:

Spacing (trees 1 - 4" in diameter) will be a growth area in future as plantations reach 10 to 20 years of age. Little has been done to date in Ontario. Hand brush-saw on a boom is the main tool at present, further trials and research will be required before large scale programs can be undertaken. British Columbia and the Maritimes have more experience in this work and Ontario will probably follow their lead.

Thinning (trees 4 - 10" in diameter) will be done more in the next five years. The main tools to date are power saw and wheeled skidder. Small, mobile, low cost feller-bunchers and skidders are needed, this is still at research level in Ontario.

Pruning is the removal of lateral branches with limited application for high value species. More production equipment is needed. At present, manual pole saws are used, with some potential to develop hydraulic shears on long poles with mobile power sources, which would reduce costs.

Cleaning is the removal of competing hardwoods from softwood regions. There are many advantages to aerial application of herbicides for weed control, the need for effective low cost ground applicators represents an opportunity for further mechanization. There are environment constraints.

In south/central Ontario, in the tolerant hardwood stands (primarily Birch and Maple), there is a need for intensive forest management. Stands should be thinned and pruned. Some intensive forest management is practised but due to lack of Ministry funding, not nearly enough is done.

5. Management Control in Silviculture

The many personnel, of both the logging companies and the government (OMNR), consulted during this study considered the potential benefits of computerization to be high. They all had a most positive and anticipatory attitude to new developments.

The situation today is dynamic and changing fast. On the one hand, there is a perceived lack of suitable software, on the other, new software is arriving quickly.

The larger logging companies are using computers and the government (OMNR) are actively expanding and perfecting their use particularly for forest inventory.

Forest products companies under FMA's use computers to store information on their forest resource inventory, areas site prepared, planted, fertilized, etc. They have to provide this information to the government. At present the OMNR districts fill out scaling and cruising and send them to the head office in Toronto. The data is processed on the IBM mainframe computer.

Each OMNR regional office now has a systems co-ordinator. The systems co-ordinator has not yet started work on forest management programs. However, it is understood that moves to decentralize the system, and standardize hardware and software are being pursued.

OMNR have an experimental digitized mapping system under development. The object is that terminals will be established in each of the 45 OMNR districts that local foresters can feed into and retrieve information.

OMNR is now considering hand held computers. The hand held computers will be used for progeny tests, regeneration surveys and operational cruising. There is a definite need for standardized software in forest management. Software programs that can be used both by the forest industry and government.

Portable computer equipment could be used to monitor site conditions and tree physiology requirements. This would ensure planting better stock suited to the site. Genetic engineering of trees themselves could be handled by the computer. Micro-processors could also be used in aerial spray programs.

The most immediately beneficial opportunity would be through the encouragement of quality standardized software.

6.2 Automation Potential in Harvesting

The process of Harvesting is relatively straight forward. It consisted of felling, topping, delimbing, cutting to length and transportation. The advantages of automation and improved mechanization are clear. The need to increase productivity, reduce delivered log costs, improve working conditions, safety and environmental damage is well defined. The difficulties lie in fitting and adapting machinery to the operating environment. There are so many factors to be conjoined. Factors such as tree size and species, terrain, stand densities, ground conditions, weather, distances, service, operators, trade unions, production volumes and capital availability.

All this means that most of the answers lie in many variations of similar solutions.

The manual chain-saw and smaller skidders are unchallenged in areas such as Algonquin because of the selective logging system and wide range of tree sizes, species and variable ground conditions. However, in the more consistent softwood forests, the opportunities for increased mechanization are strong. A representative range of the problems, considerations and current applications are contained in several recent articles included in the Reference Section.

A significant opportunity for improved production will occur when the residual bio-mass can be commercially utilized. If the whole tree can be utilized the additional yield of the forest area could be increased by the order of 30% and regeneration conditions enhanced.

Potential opportunities for a wide range of high technology enhancements of harvesting operations are contained in the proceeding of the Forest Products Research Society Harvesting Conference held in Thunder Bay, Ontario, September 1984.

Management Control

The opportunity for improved management control through the use of computer programs is being serviced by a wide variety of software. As computers have become available to literally every size of operation there has been a flood of forest industry software.

Silviculture and harvesting seem to be particularly well supplied in comparison to sawmilling.

Taking advantage of the computer programs available has difficulties. Problems of compatibility are large. Apart from compatibility with existing hardware, which is a problem for operations with large investment in hardware, there is compatibility of the software to the management systems used by the operation. Management systems have developed in an individualistic way. At this stage of the software industry's development management has to take time to be discriminating in the choice of programs, or has to commission custom programs to support their own chosen systems of operation.

6.3 Automation Potential in Sawmilling

As we move from Silviculture and Harvesting to the manufacturing processes, the operations become more standardized and controllable. Sawmills can be, and many are, highly mechanized. A high level of mechanization permits automation. This trend to automation is developing in the more technologically advanced sawmilling areas such as Scandinavia, the United States northwest and British Columbia. There are limitations, especially in the hardwood sawmilling process.

The only limitation to the complete **mechanization** of the sawmill process is high capital cost combined with the difficulty of handling the large variety of shapes and sizes which range from misshappen logs to flimsy pieces of defective lumber. Given the ability to highly **mechanize** the different sawmill process the real limitations lie in decision making. Automatic devices to sense the characteristics of the raw material and computing capability to decide and instruct the machinery to execute the optimum solution for every piece represents the limitations. It is not sufficient that sensors should be able to scan every essential characteristic and the software assess every market and manufacturing consideration. Manufacturing has to be done at an economic production rate.

High capital cost, material handling efficiency, sensor limitations and software complexity coupled with the need to maintain high production rates because of low market values constitute the constraint.

1. Sawlog Preparation

Scaling of the delivered logs can be rendered more efficient by computerized weigh-scales and portable data-entry terminals for hand-scaling.

Bucking of full length logs to optimum manufacturing and market values is probably the most profitable automation opportunity available to Ontario sawmillers. A tree length log scanner would provide all the log data to the computer such as total length, sweep, diameters along its length, and taper.

The computer would select the best bucking solution to cut the log into the highest value lengths to suit the sawmill and/or veneer plant. The actual bucking could be automated.

Sorting of the resulting sawlogs into selective groupings provides to opportunity to manufacture at higher production and lumber recovery rates. It also has the potential to optimize the raw material to the highest current market need.

2. Primary Breakdown

The equipment will vary from the carriage and bandmill systems which normally make one cut on the log per pass, to various in-line systems. The in-line systems may make all cuts parallel to each other, such as canter twin bandsaws; or may fully manufacture all faces in a single pass, such as some Chip-N-Saws. It is critical for maximum recovery that the position of these first cuts be precisely selected. Proven systems are available that can sense the **external** characteristics of the sawlog, position and transport it through the cutting tools to produce the optimum pieces.

Opportunity lies in different levels of automation. The survey determined that a low level of automation in the primary breakdown equipment could be installed. Significant improvement in productivity could be achieved at relatively low cost by installing new scanners, software, computers and controls to existing systems.

For example, if the twenty-five Ontario Chip-N-Saws, identified in Table 5.8 as probably still having obsolete or no effective process control, were to be given modern control, their profitability would be increased significantly. An increased lumber recovery, for the same log consumption, of the order of 3 to 5% would be possible. A typical modernization cost of the order of less than $200,000 would, for the large production units, be paid back in less than twelve months.

Feed Speed controls have been developed which automatically vary the machine feed-works. By sensing excess deviation in the saws, and power loads on the cutting tool motors, the sawlog can be processed at optimum speed. The resulting increase in productivity and lumber recovery benefits can be substantial.

3. **Secondary Breakdown**

The secondary operations are highly decision-intensive because every one of the many pieces being generated by the primary breakdown has to be examined and then resawn for optimum market value. Size, shape, defects, grain and the combination of potential cut pieces have to be assessed relative to current market values now that the **internal** features of the sawlog can be seen.

Optimum performance at economic production rates is beyond human capability. Automation technology is substantially available, at least for the softwood industry if not so adequately for the hardwood sawmills.

Cost of complete systems may be high, although significantly less than primary breakdown automation. Benefits can be substantial and pay-back periods for the higher production operation therefore short.

The automation survey confirmed that there are no automated secondary breakdown systems in Ontario and that few sawmills seem to be planning their installation. Only two of the twenty-five operations which participated in the survey indicated that they are planning to install trimmer and edger optimizers.

Gang Sawing can be automated by cant optimizers which position and transport the cant to extract the maximum lumber recovery. Available systems employ different levels of automation. Generally these systems do not require changes in sawmill layout.

Edging can be automated by systems which scan the lumber for the best width or combination of widths, and orient the piece for optimum lumber recovery and market values.

Scanning and software technology for softwood grading is just becoming commercially available but does not yet exist for hardwood grading requirements, therefore, grade value decisions are still mainly manual. Space requirements for optimizers are frequently more than is available in most sawmills. Sawmill layout changes to accommodate the edger automation systems are expensive.

Trimming can be automated by systems which scan the lumber for the best length, or length combinations, and move the piece or the saws to achieve the highest value. Being the last sawmill operation, this system can be used to return pieces for remanufacture. Scanning and software technology is adequate for most softwood needs, but is marginal or lacking, for hardwood grading requirements.

Grading for visual grade characteristics is not yet capable of full automation, although a few systems are in operation in Scandinavia which are able to recognize the main softwood grade features. The construction industry is moving away from visual toward mechanical or stress rated grades. As this move progresses, the market for Machine Stress Rated (MSR) lumber will significantly increase the presently marginal opportunity for automation which exists. Only one of the twenty-five sawmills surveyed was planning to install MSR capability.

Sorting is already automated in ten of the twenty-five sawmills surveyed. This probably means that most of the larger operations with available capital have taken advantage of this well established technology. The benefits are increased productivity through the reduction of manpower in one of the least desirable work areas.

Drying can perhaps be considered to be an automated process in that, after loading, the lumber remains in the kiln while heat and humidity are controlled to achieve the desired dryness. Control and computer software developments have recently provided the ability to optimize the drying process by reducing fuel needs, moisture content variation and lumber losses due to dry kiln induced defects and grade losses.

Only four of the twenty-five mills surveyed had computerized controls installed and one was planning an installation. The capital costs are in the order of $30,000 and payback can be less than six months if fuel costs are high.

4. **Saw Maintenance**

New technologies combined with fundamental research and empirical development of old technologies are providing automation opportunities in sawing.

Thin accurate sawlines for maximum lumber recovery have been the province of the high-strain bandsaw and the art of the sawfiler. Metallurgical developments in saw-tipping, saw blade design, saw-mounting and guiding are creating substantial improvements in circle saws.

The maintenance of circle saws lends itself to automation and a higher degree of quality control, with less reliance on manual "arts", than bandsaws.

Apart from saw maintenance out of the machine, new automation technologies are enabling saw maintenance in the cut. Computer controlled localized induction heating maintains the shape of the blade as deviations are sensed.

These experimental circle saw automation opportunities may create lumber recovery and production rate benefits.

5. **Management Control**

Management control can be strongly enhanced through computer applications. Software programs exist for such functions as:

- Production Monitoring
- Lumber Size Control
- Log Inventory Control
- Personnel Records
- Production Planning
- Maintenance Planning
- Lumber Inventory Control
- Personnel Training

FIGURE 5.9 - SUMMARY OF COMPUTERIZED SAWMILL MANAGEMENT SYSTEMS IDENTIFIED IN THE SURVEY

Computer Program		Systems Identified, With Comments
Production Monitoring	-	6 limited systems used
	-	1 advanced system planned
Production Planning	-	1 used
Lumber Size Control	-	1 used
Quality Control	-	2 planned
Maintenance Planning	-	1 used
	-	1 being installed
	-	1 planned
Log Inventory Control	-	2 advance systems used
	-	2 limited systems used
	-	1 being installed
	-	2 planned
Lumber Inventory Control	-	4 used
	-	1 planned
Personnel Records	-	4 used
Personnel Training	-	1 limited system used
Total Responding	-	27

The survey as summarized in Table 5.9 indicated very limited use of management computer programs in Ontario sawmills. This may be partly due to the individually developed management systems existing and the consequent lack of programs which directly meet their needs. However, some sawmill management systems can easily be standardized. Lumber size control and production monitoring are two such examples.

It was surprising that only one of the mills surveyed used a lumber size program and only one planned an advanced production monitoring system. (Six limited production systems were reported.)

Failure to use computer programs cannot be considered to be a management weakness. The scope of management responsibility in such a decision-intensive and individually unique industry is so wide and diverse that standard programs are not adequate.

Custom programs require programmers attuned to the needs of this specialized industry. The potential benefits should yield a high return on investment.

It is difficult not to conclude that lack of use of lumber size control programs indicates a substantial lack of concern with **Quality Control**. Size control is certainly possible without a computer but a dedicated pursuit of the full benefits of lumber size improvements needs the more complete analysis which only a computer can calculate. Programs are inexpensive (starting at $1,000) and well established. Benefits of a manual size control program can add something of the order of an additional 4% of lumber. Mills which have utilized computer analysis have reported additional improvements of the order of 1 to 2% attributable to the program alone. Financial return for the insignificant investment, plus continuous work, should be a very large increase in Ontario lumber production from the same log consumption and much the same production capacity.

6. Further Automation Opportunities

Because this study has determined a major lack of automation in the sawmill industry of Ontario this report has been limited to identifying commerically available systems which have been proven in similar environments and would fit existing operations. There are a range of other opportunities which would provide for new dimensions in automation for overall forest industry profitability.

Internal Scanning of sawlogs which, when capable of meeting sawmilling resolution and production requirements, could spur the development of software and production machinery to revolutionize the sawmill process for hardwood lumber particularly.

Such a concept, called **ALPS** (Automated Log and Lumber Processing System) has been conceived by the U.S. Forest Service.

Solid-wood Reassembly processes such as edge-gluing and finger-jointing cannot be considered automation but they do increase the overall potential for automation by systemizing the handling of problem and low-value material.

High-value Manufacturing such as the cutting-up of low-grade lumber to supply higher-value precut parts represents an automation opportunity. Marketing demand, combined with the need for a flexible and responsive manufacturing operation, poses an enterpeneurial challenge.

Bio-mass Conversion processes such as wood-fuel pelletizing, wood-alcohol, gassification and electrical co-generation energy systems are both a direct form of automation and a means of using the sawmill residuals.

6.4 Veneer and Plywood Manufacture State-of-the-art Review

The process systems of the various types of veneer and plywood operations, which are in existence in Ontario, and their basic process functions were described in Section 4.4. Each operation is different, reflecting the specific needs of the processed species and quality of logs, types and grades of products manufactured, volume of production allowing or limiting the extent of affordable mechanization, and many other aspects which are distinctive to a particular plant. Opportunities for improvements, modernization and automation probably exist in all operations, if for no other reason than because of the changing economic environment, starting with the raw material source and ending with the market conditions. A justification for automation of certain size and type of operation is highly individual and subject to a specific investigation.

A complete description of a state-of-the-art veneer and plywood plant would be, to a large extent, a repetition of the description of the basic process functions included in Section 4.4. Highlighting the most important recent innovations, typifying a modern operation, would serve better to meet the objectives of this survey.

1. Block Preparation

Log handling and preparation methods and potential for automation in this area would be the same as for sawmilling as described in Section 6.3.

Conditioning of the blocks is the only major process function in the log handling area which is characteristic to veneer plants. A state-of-the-art plant has the heating system designed as a closed loop system, with hot water recirculating through primary and secondary filters and reheating system. This is an environmentally desirable, low maintenance arrangement.

2. Green Veneer Production

Block centering and lathe charging is probably the area where automation could be most rewarding. Various rudimentary methods now being used for these functions can now be accomplished by an optimizing automation X-Y charger.

A scanner reads the measurements of a block and feeds the information about the block profile into a computer. The X-Y charger receives the information from the computer and positions the block for greatest possible recovery. A video screen in the lathe operator's cabin provides a continuous read-out from the computer. A terminal in the computer room provides a print-out for each shift showing the block count, block scale, loss through spin-outs, full sheet and fishtail footage, recovery, average block diameter, etc.

The information from the computer about the previously scaled block diameter controls the knife carriage to retract to safe distance to clear the incoming block. The back-up roll is similarly controlled to swing up just enough to clear.

The benefits of using an X-Y charger could be a significant improvement of wood recovery and operating efficiency.

3. Veneer Drying

The performance of the veneer drying equipment is enhanced in the state-of-the-art plants by the application of a dryer management system. It includes moisture detectors, computer and a control unit. The dryer management system controls all the functions of the dryer to achieve the best efficiency of operation at a desired level of redry.

4. Dry Veneer Preparation

The efficiency of this area of the plywood plant depends on a smooth material flow, employment of reliable equipment and a thorough quality control rather than on automation.

5. Lay-up and Pressing

The lay-up and pressing area of a modern plywood plant includes at least some, if not all, of the following features:

- An automatic lay-up line and glue application system.
- A cold pre-press consolidating the lay-ups.
- A press line with automatic press loader and unloader.

Here again a softwood plywood operation differs from a hardwood mill. One innovation now available for press area is a press controller which enables multi-step and position pressing.

Recent studies have proven that substantial reduction of compression loss is possible through step or position pressing of plywood rather than single pressure process. To convert existing presses to automatic control, requires minor hydraulic modification for the controller. Savings can be achieved by reduction of veneer thickness during peeling.

6. Finishing

The finishing area of a state-of-the-art plant uses modern, highly efficient equipment, but the operating methods do not differ from traditional operations.

6.5 Reconstituted Wood Products Manufacturing State-of-the-art Review

The process systems of various types of reconstituted wood board plants, typical of those employed in Ontario, were listed and briefly defined in Section 4.5 of this report. The production of reconstituted wood panels, being a continuous and almost completely automated process, differentiates it from veneer and plywood operations. The potential for further automation in these plants is limited. The most recent contribution to the group of reconstituted wood plants is a waferboard/OSB process. It will be described in more detail.

Wafers (flakes) for the conventional waferboard process are cut nominally 40 mm long parallel to grain, 0.6 mm thick and have typcially a square shape when discharged from the waferizer. This type of wafer is perfectly suitable for random spread (unoriented) mat for standard waferboard products. However, most of the plants installed in the last two or three years opted to have a provision to produce Oriented Strandboard (OSB). In this case the flakes (strands) have to have a slenderness ratio at least 3 to 1 (length to width) to be suitable for alignment. To meet this requirement and achieve the desired physical properties, at reasonable resin and density levels, the flakes have an elongated shape, nominally 60 to 70 mm long and 15 mm wide.

One of the two following waferizing methods has been used in practically all existing waferboard/OSB operations in Canada and the United States. They involve either disc or drum waferizers.

The CAE waferizers have vertical discs and are fabricated in two sizes. The smaller (original model) machine has 20 knives and is designed to handle wood pieces of the uniform length 600 mm. The bigger waferizer has 24 knives and handles blocks 860 mm long. The blocks are guided sideways to the disc, with wood grain parallel to the knife edge.

Two banks of feed chains grip the blocks firmly by the ends and advance them towards the disc. The knives slice uniformly thin, smooth veneers of wood. The desired thickness of flakes is controlled by the feed speed relative to RPM of the disc and the projection of the knife.

The length of the wafers is determined by the selected serration of the knives. The wafers pass through the knife slots to the discharge side of the disc and therefore minimum splinters or fines are generated.

The application of this waferizing method is usually considered in cases where the available wood source is roundwood, which is reasonably straight, so as not to pose a problem at slashing into short blocks, and feeding the wood pieces to the disc.

The second commonly adopted waferizing method is with the use of drum waferizers. In this case the knives are arranged on the surface of a drum. Two basic types of drum waferizers are available. One type is designed so that wood blocks, 1.2 to 2.4 m long, advance toward the rotating drum sideways. The other type of drum waferizer conveys wood stacked onto a trough conveyor into a cutting chamber where the rotating drum travels into the wood, and then reverses direction for the next cycle. The length of flakes cut in this method is determined by the serration of knives. The thickness is controlled by the rotation of the knife drum and the feed speed of wood or drum respectively. The cutting pattern in this case does not indicate a parallel slicing of flat thin veneers.

The waferizing methods described above have many obvious assets, but they are limited to applications where the incoming wood allows reasonably efficient handling. The third available way of cutting flakes, involving a combination of maxi-chipping and ring flaking, may be in certain cases, more advantageous from the point of view of production costs or even of necessity if the available wood is such that no other waferizing method could be applied.

For the maxi-chipping/ring flaking concept, the incoming wood is reduced by maxi-chipping to large chips, nominally 60 to 70 mm long, 35 mm wide and approximately 15 mm thick. This is a preprequisite for the subsequent cutting into flakes of the desired geometry. The chips are washed and screened. Oversize or card-type chips are rechipped and returned to the main material flow. The washed and screened material is metered into ring flakers which produce thin slender flakes.

The ring flaker has a slowly rotating or stationary knife ring with 30 to 50 knives protruding inside the knife wheel. A fast rotating impeller, with plates acting as anvils pushes the chips against the knife blades. The setting of knife edges relative to internal diameter of the knife ring is the basic criterion for the control of flake thickness.

The flakes pass through the knife slots of the ring and discharge through the bottom opening of the machine. The centrifugal force of the impeller causes the incoming elongated chips to lie sideways on the plates which means with wood grain parallel to the knife edges. This assures slicing of flakes with the required slenderness ratio, suitable for orientation and with sufficient length of fibre to produce boards with acceptable properties.

The remaining production procedure is basically the same as is the case for the other waferizing concepts. Green flakes are metered into a dryer where the moisture content is reduced to approximately 3%. The dryer system includes an insulated drum rotating on trunnions. The heat source could be pulverized wood residue, oil or natural gas.

Flakes pass through the dryer in a stream of hot air and are discharged through cyclonic separators onto a collecting conveyor. Dry flakes are screened to remove the undesirable fine dust and to classify the flakes for larger size surface layer flakes and smaller size core layer fraction. Dry flakes are metered into blenders and mixed with 3 to 5% (solids) of liquid phenol formaldehyde resin and approximately 1% of slack wax. Blenders with airless spray nozzles or fast rotating atomizing disc heads are available. Flakes blended with resin and wax are conveyed into the individual heads of the forming station.

The mat forming heads are essentially wide belt distribution bins designed to feed a uniform volume of material to the forming heads across the width of the forming line and along the length on a continuous basis. These forming heads have level detectors to precisely maintain the amount of flakes in the forming head and therefore control the bulk density of the metered flake flow.

The forming station usually has one bottom-face forming head, two core heads and one top-face forming head. All of these heads can be equipped with flake orientation devices which align the face flakes lengthwise and core flakes crosswise in respective layers.

The forming line uses the screen caul system to support the mat. Screen cauls allow the moisture in the mat to escape more readily when pressing, and therefore permit press operation at higher moisture levels than with solid caul plates.

The screen cauls receive material from the four forming heads and continue on the caul line to a flying cut-off saw which removes material deposited on the two bars. This material is recycled to the core blender system.

The screen cauls then enter a speed-up system for separation, and a reject section where an unacceptable mat, as well as the screen caul, can be removed from the forming line. These rejected mats are recycled to the blender feed bins.

After the reject station, a storage conveyor is provided ahead of the press loader to store mats while the press is being loaded.

The screen cauls, with mats are loaded into the press loader on alternate spaces as the loader is indexed down and then up. This permits the most efficient use of the time available. From the press loader, the screen cauls are transported into the press.

The multi-opening hot press is in most cases nominally 2.4 m wide and 4.8 to 7.2 m long. The press system is based on a hydraulic system which will deliver 50 kp/cm^2 specific pressure to the mat. All cylinders are individually controlled through pumps and relief valves to maintain positive thickness control. The press is equipped with simultaneous closing arms to allow all platens to be closed simultaneously to prevent precure.

Upon completion of the pressing cycle, the screens and pressed panels are withdrawn from the press by the two bars on each screen into the unloader.

The unloader indexes down and the screen cauls are separated from the pressed panels as they leave the unloader. The cauls are then returned on conveyors under the press to a caul accumulator and hence to the start of the forming line.

The press heating is usually based on using thermal oil heated by natural gas, fuel oil or pulverized wood residue. Heated oil is pumped through a recirculation loop which provides heat for the press and also for resin and wax areas.

Immediately after leaving the press, the panels pass through a non-contact in-line blow detector which can mark the areas of panel defect.

A 360° rotary board cooler capable of holding one to two press loads is provided in the conveyor line to the trim and splitter saw. The purpose of the cooler is to reduce the panel temperature from approximately 170°C when leaving the press to about 90°C before entering the grade bins.

From the cooler, the panels are conveyed either directly to the trim and cross-cut saws, and subsequently graded and stacked, or diverted from the line to a full size stacker/feeder. From the stacker/feeder, the panels are unloaded with a forklift truck and re-entered as required later.

All board trim, together with the sawdust from the panel saws, is reduced in a trim hog and blown into a fuel storage bin in the dryer area for further pulverizing. A diverter switch can be included in the high pressure blow line to dump the board trim in case of reduced demand for dry wood fuel.

A tongue and groove line can be provided for specialty products for 1.2 m by 2.4 m maximum panel size. This line may have provision for face grooving.

A wide belt sander with two staggered combination heads and two opposed heads can be provided to calibrate and sand the panels for specialty products. A mirror station and a two or more bin grade line is required for grading of the finished panels.

7.0

CONSTRAINTS TO AUTOMATION

7.0 CONSTRAINTS TO AUTOMATION

Constraints to automation in the Silviculture, Harvesting and Sawmilling sectors of the forest industry of Ontario are formidable. The operating and economic environment is hostile to investment and to new technologies.

1. Operating Environment

Distances, climate, terrain, lack of operator and maintenance worker skills, remoteness from specialized services and other such factors amount to a substantial constraint to automation. Yet these factors paradoxically contain incentives to automation. Consider these opinions on automated log harvesting machines in the northern forest:

- large integrated Feller-Delimber-Forwarder packages;
  - very costly
  - difficult to maintain
  - a necessity to keep log costs economic
  - a necessity in view of labour shortages and absenteeism
  - require extensive operator training
  - trade unions insist on allocation of operators by seniority without training if necessary
  - site specific
  - only effective in 50% of the northern forest.

2. Neglected Forests

The neglected forests, depleted of the larger sized, higher quality and more valuable species trees, adversely affect the mixed species and hardwood operations particularly. The lack of adequate raw material maintains the production of many hardwood sawmills below the economic threshold for significant automation opportunities for many operations.

Automated machinery, indeed any modern mechanized systems, are highly capital intensive. Justification of investment requires considerable production, usually two or even three shifts per day. Limited log supply and too many producers create this constraint.

3. **Market**

Distance from markets, lack of marketing expertise, strong Canadian dollar and exposure to foreign competition at home and abroad are all are factors which restrict cash flow, limit cash reserves and inhibit investment.

4. **Low Value Products**

The sawmill industry is substantially locked into low value markets: the softwood producers because of the need to maintain low unit costs of production, the hardwood producers because of the burden of low quality material they must harvest.

This constraint is well recognized by the industry but, being based on production realities, is not easy to escape. The realities are that, in general, sawmills are only able to cope with some of their other constraints, mainly market and high labour costs, by operation on a mass-production basis. This means that their production machinery and whole infrastructure, including marketing, is heavily locked into the supply of standard commodity lumber to the North American construction industry.

5. **Limited Residuals Markets**

Limited demand and consequent low prices for pulp chips increase the quantity of low-grade lumber (hardwood especially) to be marketed, keeping prices low. Minimal to no demand for sawdust, shavings and forest residuals adds to manufacturing costs and decrease overall productivity and profitability.

6. **Lack of Capital**

Poor market performance and cash flow, international trade uncertainties, government deficits, U.S.A. tariff threats, recent high interest rates and heavy debt/equity ratios. All are factors militating against the large investments required for automation.

7. **Economy of Scale**

Out of the 759 sawmills which operated in Ontario in 1983 it is possible that only some 50 to 60 could economically support significant levels of automation. Major rationalization and re-structuring of the industry will eventually evolve. The most exposed are those dependent on the marginal and depleted forests and the less efficient of the smaller producers. (Many of the small privately owned and managed operations will survive, as they have always done).

8. **Lack of Secure Forest Tenure**

Many operations do not have, or have only recently gained, a secure forest base. This prevents long term investment committment.

9. **Lack of Expertise**

Ontario feels a sense of isolation from much of the rest of the forest industry. A lack of skills is perceived throughout operating mills. A relative reluctance or inability to visit high-technology operations sustains the isolation. A tendency to think that automation and high-technology requires knowledge or skills that are not readily acquired, hinders learning.

These constraints and beliefs exert wider negative influences. For example: forestry and engineering consultants, machinery suppliers, and others who are part of the technology transfer process are not as actively involved in the forest industry of Ontario as they are in that of other provinces.

10. Cost of Innovation

We cannot expect to translate an automation system, successfully performing in one operating environment, into a different operating environment without making adjustments. The cost of the adjustments will affect the economic justification.

The introduction of automation systems into the challenging environment of many of the operational sectors of the forest industry will be particularly costly. The initial cost of innovation may be so great that there may be no initial cost justification. The market which the forest industry represents is not large compared to many other industries having less challenging operational environments. Therefore, the commercial production volume and incentive to introduce new systems is low.

A successful machine system

- performs the job adequately
- has the right size, weight, and price
- operates at acceptable cost
- is designed for the job
- contains reliable components
- is supported by adequate training, maintenance and parts services
- is operated, maintained and supervised by skilled personnel whose motivation and attitudes are positive
- is supported by successful operations and maintenance programs.

It is the cost of changing both the automation system itself and modifying the operational environment to accommodate the new system, that is the constraint.

11. **Lack of Education**

(The following is speculation and is not the result of study).

The level of management staff education in terms of formal technical and business training, especially continuing education in contemporary technical and management sciences, is probably low compared to the management staff of other high technology industries. (This is probably more true of sawmill management staff than of silviculture and harvesting). Yet the rate of technological development and need to automate is impacting the sawmill industry more severly than most at this time.

The transfer of high technology from the advanced industries to the sawmill industry happened only recently. The transfer was not only late but slow and difficult. Therefore, most of the industry's automation systems, computer programs, etc., are still of an early generation and are obsolete.

The leadership drive required to apply more advanced systems to machines and to management methods must come from management and their technical staff, although few sawmills can afford technically educated staff.

12. **Attitudes and Perceptions**

Attitudes and perceptions are what create and change all our institutions. The Ontario forest industry appears to experience enough negative attitudes and perceptions, both in itself and how it is considered by others, that these have to be regarded as a constraint to automation. The sawmill industry seems to be more adversely affected than any other sector of the industry.

Some examples which illustrate this constraint are :-

- The forest industry is not considered to be strongly organized within its own ranks. The wide variety of business activities, the diversity of processes and the vast range in size of operations all inhibit a unity of interest. The industry is therefore denied the advantages of the more unified and highly organized industries or trade associations.

- The forest industry does not have such an appealing or stimulating profile as other Ontario industries. This provides the impression that, for this reason, they receive disproportionately lesser amounts of government financial support and public sympathy.

- The impression is that even the Technology Centres of the Ministry of Industry & Trade are not having a direct influence on the forest industry. The Sudbury Centre for Resource Machinery Technology does not include manufacturing in its mandate. Therefore, the sawmilling industry particularly is not seen to be receiving technological support from this stimulating program.

- The industry is seen to be traditional and conservative. This is a generalization and there are many exceptions. However, these exceptions, individuals and organizations of enterprise and innovation, do stand-out and tend to confirm the negative assertion.

All of the constraints mentioned in this section, and many more, create a reluctance to venture into automation.

8.0

OTHER OPPORTUNITIES FOR PROFITABILITY IMROVEMENT

8.0 OTHER OPPORTUNITIES FOR PROFITABILITY IMPROVEMENT

This study has identified substantial constraints to automation in the Silviculture, Harvesting and Sawmilling sectors of the forest industry.

However, the study identified other opportunities for profitability improvement, most with less constraints. Although these opportunities are beyond the scope of the Automation Study they have been outlined in this section.

Some of the capital costs of these other opportunities are small and the return on investment large. Some do not require high technology. Some can start providing benefits quickly. Most require increased technical staff assistance for management.

Lumber Marketing

The need to obtain higher market values is crucial. Sophisticated, creative marketing and improved communications are essential.

Comparison between Swedish and Canadian achievement in profitability improvement over the last decade provides incentive. The average value, in constant 1982 dollars, per unit of lumber exported from Canada increased 16 percent and from Swedish sawmills, 80 percent. The Scandinavians made a major effort to extract more value from the raw material. Our mills have concentrated on reducing unit production costs, frequently by increasing production, contributing to oversupply and decreased market prices.

Total Quality Control

This study has raised suspicions of a very low level of Quality Control in sawmilling generally. If the suspicion is correct there are substantial recovery and value improvements to be gained.

The management science of statistical quality control is the analytical search, throughout an entire operation, for problems which are the opportunity to improve productivity and profitability. The forest industry is rife with such opportunity and many of the more managerially advanced companies are achieving substantial benefits from Quality Control programs.

Leding and Bowyer in the Forest Products Research Society Journal of November/December 1984 speak of a "quiet revolution" taking place in the United States and describe the wide range of applications in the forest industry. Perhaps they use the term "Quiet Revolution" because the industrial transformation taking place is different than the loudly heralded "Computer Revolution". It certainly is less "high-tech", more fundamentally human and understandable.

The whole process of managing industrial productivity improvement has statistical Quality Control only as a beginning. For example, in the sawmill, the process would begin with the improvement of sawing accuracy and would continue to identify the opportunities for improved lumber recovery in bucking, trimming, drying, etc.

It should lead to the pursuit of productivity improvement opportunities by means such as flow analysis, identification of problem areas, work analysis, downtime analysis. The sawmill lends itself to the benefits of heightened awareness of opportunity through the application of the "Just-In-Time" concept.

Take the sawmill sector of the Ontario industry as an example again. If we can assume that the suspicions about a very low level of Quality Control are correct, then the productivity and profitability opportunities are most significant. Lumber recovery improvement through improved size control could provide initial benefits of the order of five percent. Moving from size control through the other techniques of Total Quality Control could bring productivity and improvement benefits of the order of twenty percent. This means that up to 20% more (and better) lumber could be recovered **from the same log volume.**

Overall productivity and profitability improvements of such orders of magnitude have been obtained in sawmills through Total Quality Control techniques alone. The investment is in people and systems, not in the machinery.

Motivation and Productivity

The all-important drive for improved quality of work-life, job enrichment, motivation and development of total involvement in the well-being of the industrial operations which is revitalizing other industries may not yet be affecting this industry. The startling growth in productivity achieved by the average Japanese worker is being emulated in North American industrial situations. People oriented management systems, with workers assuming a much more substantial role, are natural to our industrial system also.

Improved Machines and Systems

All machines have limitations, all processes can be improved.

Careful observation and judgement based on experience will identify endless opportunities for improvement in every operation. Critical analysis of cost and benefits under different operating conditions and ranges of values in the significant variables are necessary to select the optimum opportunities. Whether the improvements involve refinement of existing machines and systems, or installation of new, management need the most complete knowledge possible.

Industrial engineering techniques. knowledge of machine and system capability, production simulation and other programs exist. Practical means have to be found to make them more widely available to the management staff of the industry.

Management Skills

It is clear that the forest industry requires radical changes in productivity to become competitive in world markets. These changes will have to be created by the management staff. For good reasons, such as distance, lack of educational opportunities, economic viability, not having the size to justify specialized staff and the existing competent staff simply being overworked, the skills of management (in sawmilling particularly) are believed to be behind the needs of the industry today.

The need and incentive to acquire improved management capability may, or may not, be widely recognized. Short and long-term educational programs, operator and trade training courses, seminars, tours of high technology operations and other technology transfer processes may provide the means.

This single opportunity is the key to the other opportunities. The need, incentive and means to acquire improved management capability is paramount.

Management Computer Software

The forest industry represents a most difficult and complex management task. The diversity of the operations ranging from harvesting, manufacturing, and delivery of finished products to a most diverse and competitive market have to be knit together. Most of the operations are performed by individuals faced by variable conditions who are required to make their own judgements. It contains many highly decision-intensive processes.

The opportunity for improved productivity and profitability lies in providing management with the capability of knitting together the intricate and incredibly fine detail of the total process. Computer programs have the potential to assess the complicated inter-action of decisions. They also provide the means of presenting exact information for the task in hand, by all involved in the operation.

Computer programs have several advantages. First, they have the ability to store knowledge and, assessing the complexities, present their solutions swiftly. They also provide a frame-work of systematic work, a means of acquiring and accumulating knowledge, of co-ordinating activities. This provides organizational benefits.

One other advantage, possibly of high importance to the Ontario Industry at this time, is that they can teach. Good programs can bring understanding and incentive to improve productivity and profitability in the function they are fulfilling.

Their development and application for the varied operations of this industry will not be easy. However, the whole process of development and application is, in itself, most productive of new knowledge and recognition of new opportunities.

The whole object of management computer software is to free man from detail so that he may apply his wider understanding to the process under his control. A sawmiller should be a sawmiller.

Individual Entrepreneurship

This is an industry of individually owned and managed operations existing alongside major corporations. For responsiveness, efficiency, willingness to venture and innovate, the smaller operators are known to set a fast pace. They will need support in this era of management skills and high technology.

This support may be in the way of financial assistance to make available opportunities or capabilities otherwise denied to them. For example :-

- Assistance in forming marketing or manufacturing consortia.

- Development of secondary manufacturing opportunities or introduction of new processes.

- Providing encouragement to other industries to utilize forest industry by-products or residuals.

- Making possible specialized training programs in their localities.

- Strategic planning of consolidation of operations.

New Processes

Value-added manufacturing processes will increase the profitability of the industry and provide opportunities for individual ownership.

Processes to utilize problem materials (small logs, chips, refuse) will increase the profitability potential of the remainder.

9.0

RECOMMENDATIONS

9.0 RECOMMENDATIONS

The main concentration of this study was on the application of automation technology in the forest industry in Ontario. However, the study determined that there is in fact, little automation and that the industry is not benefiting from advanced technology to the same extent as the other industries. It also identified severe constraints to both high technology and to the introduction of sophisticated machinery. Despite these handicaps, there is a critical need to improve productivity and profitability.

Based on these considerations, and being aware that the Ministry intended this to be a broad review preparatory to further work, it is recommended that further study should be directed with some urgency to the introduction of high technology with respect to:

- management and marketing skills
- improved machinery
- new processes

It is recommended that a steering committee from both industry and government, establish directions and priorities for a program to provide encouragement, and incentives for learning and development. It is suggested that the areas of highest potential benefit are:

Management Skills

- Marketing and the manufacture of higher value products.

- Quality control in the fullest sense of searching for better ways to do things.

- Employee motivation, training and involvement.

- Management computer programs.

- Support of the smaller operator through assisted studies, formation of consortiums, strategies of rationalization, etc.

Improved Machinery

- Improving the productivity of existing machinery.

- Automating the existing machinery.

- Modernization through new machinery.

New Processes

- Higher value-added manufacturing processes.

- More complete and higher valued utilization of residuals.

The introduction of higher technology in the foregoing areas will require an evaluation of the existing training facilities, such as the Technology Centres and educational establishments, to identify the most effective means to be employed.

From the perspective gained of the need and the structure of the Ontario sawmill industry, two examples of appropriate technology transfer programs are submitted to illustrate this recommendation.

First Example: **Mill Visits**

Small teams of experts (three or four) visit selected mills for a two or three day intensive review. They then make a factual presentation of practical low-cost/fast-return improvements in manufacturing productivity. At the same time, give broad indication of higher cost improvements through modernization.

While in the area, the same team makes a presentation to local government, business associates, etc., in a session designed to outline how appropriate secondary industry may complement their existing industry.

Second Example: **Area Workshops**

Experts on single specific operating or maintenance technologies visit different sawmill centres. Working with a small group of specific operators and their supervisors, they review practices, provide instruction and set up tangible improvement objectives for their own specific plant needs. This process would be reviewed with the plant management. After an appropriate interval the expert, who has been on call for consultation, would return to evaluate progress and monitor performance.

Ideally this would be done in groups drawn from different local area sawmills so that the participants would benefit from a shared experience and mutual support of an ongoing nature.